THE ALCYONARIAN FAMILY XENIIDAE, WITH A REVISION OF THE GENERA AND SPECIES

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WITH FIVE TEXT-FIGURES AND TWO PLATES

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THE FAMILY XENIIDAE.

THE Xeniidae form a well-defined family with a combination of characters which distinguish them from all the other Alcyonaria.

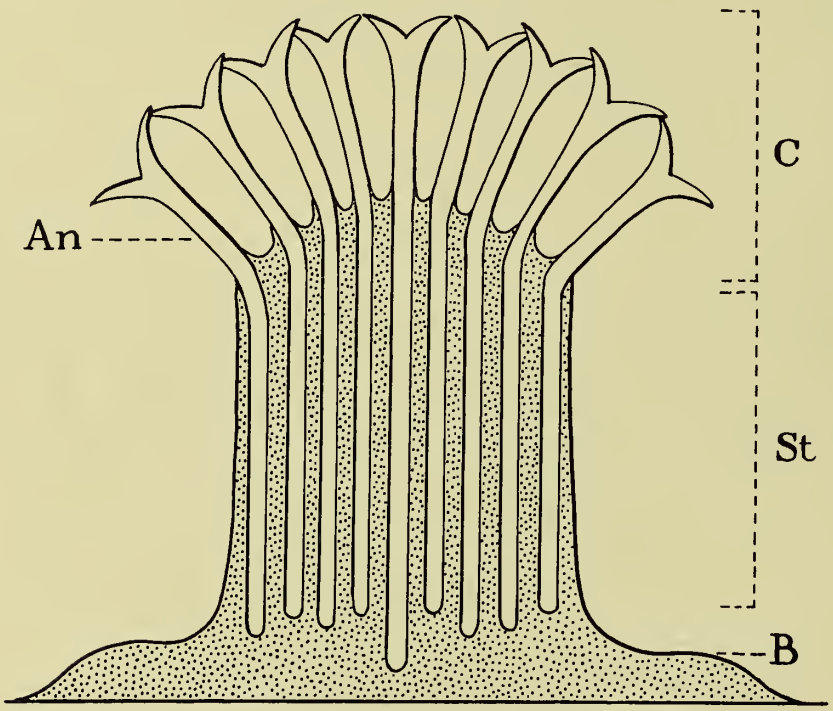
It is difficult to give a precise definition of the family, but the following statement, subject to the explanatory notes which follow, may be taken to indicate the characters by which its members may be identified.

The Xeniidae are soft fleshy Alcyonaria with comparatively slow powers of contractility. The polyps possess only one pair—the dorsal pair—of mesenteric filaments. The tentacles usually possess on each side two, three or more longitudinal rows of pinnules. Calcareous spicules, when present, are minute, round or oval corpuscles, rarely rod-shaped.

Explanation of Some Terms Used in this Paper.—If we examine a specimen of what we may call a typical *Xenia*, we find a base by which the colony is attached to a coral or some other support, which may extend into a thin membranous expansion over the support. From the base rises a smooth and usually cylindrical stalk, terminating above in a dense cluster of polyp heads which I have called the capitulum. In a vertical section it can be seen that the polyp cavities extend from the crown of tentacles through the stalk to the base, or to a considerable depth in the substance of the stalk as in *Alcyonium* and many other Alcyonaria.

Morphologically therefore the polyp consists of an upper free portion—the anthocodia —and a lower portion bound to its fellows by a common coenenchym.

In previous papers the word " polyp " is generally used for the anthocodia only and to avoid misunderstanding I have used it in this sense throughout, but it should be borne in mind that the polyp in this sense is only the free part of the morphological polyp. The stalk, being composed of a bundle of the lower portions of the polyps bound together by coenenchym, is a " syndete " in contrast to the mass of anthocodiae, which I have called the capitulum, and is in Prof. Bourne's (1900) terminology an " apodete."



Text-fig. 1.—Diagram of a Xenia to illustrate the use of some technical terms. *B*, the base of attachment with membranous expansion; *St.*, the stalk or syndete; *C*, the capitulum or apodete; *An.*, the anthocodia of the polyp, usually called the polyp. The basal parts of the polyps are joined together to form the syndete.

Contractility.—Specimens of Xeniidae collected in the ordinary way and sent home in spirit have usually expanded polyps, in contrast with many other Alcyonaria in which the polyps are more or less contracted with their tentacles infolded when preserved.

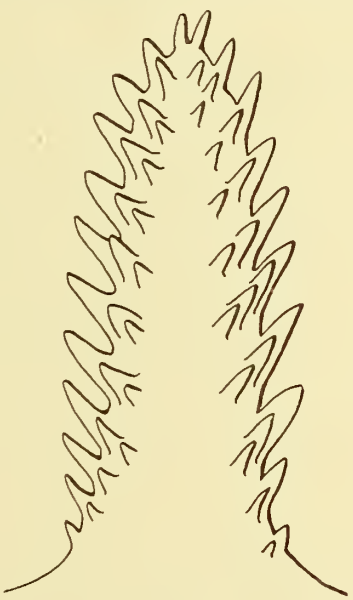
It is true that, with a few exceptions, the polyps are not retracted into the coenenchym nor into the shelter of verrucae, but there can be no doubt that they all possess considerable powers of contraction. The muscular system of the Xeniidae does not differ materially from that of other Alcyonaria, and we have the direct evidence of a few field notes to support the anatomical deduction. Dana (1848, p. 606), for example, wrote that in *Xenia florida* the polyps contract to one-half their full size when taken from the water.

We can form no true conception of the contractility of these Alcyonarians until a great many more accurate and detailed accounts of it are provided by those who have the opportunity to study the Xeniids alive upon the reefs.

The impression the study of preserved material has given me is that the polyps of the Xeniidae contract more slowly than they do in other Alcyonaria.

It is possible that some writers may have been misled by a statement by Saville-Kent (1893, p. 196) that " the component polyps (of *Xenia*) are entirely incapable of contraction." It is probably true that the polyps of many Xenias are entirely incapable of " retraction," but they are all capable of some degree of contraction.

The Mesenteric Filaments.—The absence of the ventral and lateral mesenteric filaments in a species of *Xenia* was first discovered by Ashworth (1898). Since then it has proved to be the most important distinguishing character of the family. I have examined a very large number of specimens of the four genera belonging to the family, and in every case these six filaments were absent. On the other hand they are present, so far as my



Text-fig. 2.—A diagram of a tentacle of a Xenia to show the arrangement of the pinnules in oblique rows of 3–4 and three longitudinal rows on each side.

experience goes, in the full-grown polyps of species belonging to all the other families of the Alcyonaria.

The Tentacles.—The typical Alcyonarian tentacle is provided with a single row of pinnules on each side and is said to be " pinnate." In the majority of the Xeniids there are two, three or more rows of pinnules on each side of the tentacles.

It has been shown (Thorpe, 1928, p. 490) that in an early stage in the development of the tentacle there is a single row on each side as in other Alcyonaria but the additional rows are added as the tentacle grows to its full size.

In some cases when the tentacle is fully expanded the pinnules are arranged as represented in the diagram (Text-fig. 2). There are three or four pinnules in a row running obliquely across the tentacle on each side—the oblique rows—and each of these pinnules is a constituent member of a row running longitudinally from the tip of the tentacle to the base—a longitudinal row.

In such an expanded tentacle the pinnules may be all elongated cones in shape, and it is possible that in a healthy expanded living polyp they are always of that shape.

In preserved specimens the pinnules are usually much more unevenly distributed, and it is often very difficult to count the number in the oblique and longitudinal rows with accuracy. They have frequently the appearance of being quite irregularly scattered over the oral surface of the tentacles.

Moreover, in many of the preserved specimens either the whole of the pinnules or those of the inner longitudinal rows are contracted into the form of warts or low mounds. This matter, however, is discussed more fully in a subsequent section (p. 146).

Spicules.—I think there can be no doubt that some Xeniidae are entirely devoid of spicules ; but, when present, they are always in the form of minute round or oval discs, or more rarely thin rods. The spindles, needles, capstans and other forms of spicules which are so common in other groups of Alcyonaria are never found in this family. In the Pennatulid *Scytalium* small disc-shaped spicules 0·05 mm. in diameter are found, but in other families they are very rare.

Another point of great interest about these spicules is their remarkable uniformity in size. With a few exceptions these spicules range from 0·02–0·025 mm. in diameter.

In some species there may be spicules a little above or below these figures, but what is very striking is that when a large number of specimens from the tropical seas are examined, the variation in the size of the spicules is so small. A remarkable exception is found in *Cespitularia mantoni*, where the round disc-shaped spicules are 0·1 mm. in diameter, that is to say four times the diameter of the spicules of all the other specimens of Xeniidae from the Barrier Reef that I have examined (Text-fig. 5, p. 168).

Colour.—Many naturalists have described the delicate colour of the living Xenias, but at present it is not possible to make use of the colour characters in systematic work. Moreover, the chemical and physiological natures of these colours, which are soluble in spirit, are entirely unknown.

The most prevalent colour is pale blue, " a porcelain or electric blue " according to Saville Kent. Crossland, in a private letter, has told me that in Zanzibar he saw many blue Xenias. Several of the specimens described in this paper were labelled " blue." On the other hand many references to other colours will be found in the literature. Saville Kent, for example, gives coloured illustrations of Xenias that are " beryl green," pink, yellow and slate coloured, and Yonge describes a delicate dove-grey *Xenia* on Pixie Reef (1931, p. 140).

It seems very probable that, as with our own common sea-anemones, the colours of the species are very variable. The case of *Cespitularia coerulea* of Zanzibar lends strong support to this view. May (1900, p. 90) described the species as flesh-coloured with a tinge of bright blue. Crossland described the colours of three specimens of the same species, identified by Thomson and Henderson (1906, p. 415), as (1) " brilliant sea green," (2) " pink stems," (3) " pink body with blue-green zooids."

Gonads.—It would be of great interest if we possessed some knowledge of the time of spawning of the different species of the Xeniidae. If they all spawn at the same time some of the varieties may be hybrids ; if, on the other hand, there is an interval of one or more months between the sexual periods of the different species hybridization would be checked or prevented. On this point our knowledge is so scanty that it offers no solution for the problem.

The following notes on the presence of gonads in the dated specimens I have examined may be of some value for future investigators :

All the specimens with gonads were dioecious. There was no evidence of hermaphroditism at any stage. Unfortunately most of the specimens showed no gonads when examined with a lens, and it may be inferred therefore that they were not nearly ripe sexually. *Heteroxenia elisabethae* collected at the end of May had female gonads 0·75 mm. in diameter. *Cespitularia mantoni* collected in July had small male gonads 0·15 mm. in diameter, and a specimen of *Xenia plicata* collected in August to September had small female gonads 0·2 mm. in diameter.

All the other specimens were collected either in April or May and showed no gonads.

On Dimorphism in the Xeniidae.

The question of the dimorphism of *Heteroxenia* has been a subject of controversy for some years, and there can be no doubt that the correct interpretation of the facts in this case must have an important effect on the classification which should be adopted. Briefly stated the problem is as follows :

Is there a true anatomical and physiological dimorphism of the zooids in *Heteroxenia elisabethae* and some other species ; and if so, is the dimorphism of generic importance ?

Kölliker (1874) was the first to describe as dimorphic a specimen from Port Denison, in Queensland, which he named *Heteroxenia elisabethae*. He pointed out important differences in structure between the siphonozooids and the autozooids.

Haacke (1886), from an examination of specimens of the same species from Torres Straits, came to the conclusion that the siphonozooids are only young autozooid buds and that, therefore, there is no true dimorphism in the species.

May (1900) examined specimens from Zanzibar which he considered to belong to the same species and gave support to Haacke's opinion. May, however, studied the structure of the zooids more carefully, and pointed out a difference between the siphonozooids, which have incurled tentacles, and the young autozooids, which never have their tentacles incurled. As he did not discover any other difference between them he considered that they are not morphologically distinct. His contention that these zooids cannot be true siphonozooids because they bear rudimentary tentacles was not sound, as a tentacle occurs on some of the siphonozooids in the Pennatulacea (Marshall, 1883, and Kükenthal and Broch, 1911).

When May published his paper he had not seen, apparently, Ashworth's account of the same species from Zanzibar which appeared in the previous year.

Ashworth's examination of the zooids was much more thorough than May's. He found a constant difference in structure between the siphonozooids and young autozooids of 2 mm. or more in length, and that the young autozooids bear sexual cells and the siphonozooids do not.

Ashworth agreed therefore with Kölliker and Bourne (1895) that *Heteroxenia elisabethae* is truly dimorphic.

Kükenthal (1902) agreed with May that the genus *Heteroxenia* should be suppressed, and he classified *H. elisabethae* and some other dimorphic species with the species of *Xenia*, but accepted the view that dimorphism does occur in the Xeniidae in a form not very sharply defined. ("Einige Arten mit wenig ausgeprägten Dimorphismus der Polypen.")

Two years later (1904) Kükenthal published a paper in which he described under the name *X. fuscescens* a number of specimens collected by Dr. Hartmeyer principally near Tor, off the Sinai peninsula. He said that in this species there is great variability ; there

are examples without dimorphism, examples with pronounced dimorphism, and between them intermediate forms (p. 38). There are also some with spicules and some without spicules. The absence of spicules and the pale transparent colour seemed to be correlated with the absence of dimorphism, the dimorphic forms being darker in colour and provided with abundance of spicules. In 1911 Kükenthal's pupil Cylkowski wrote a dissertation on the dimorphism of the Alcyonaria, in which he described his investigation of thirteen specimens of this species from Jidda in the Red Sea. Four of these specimens were dimorphic, the others were not dimorphic. No mention is made of any intermediate forms beyond the statement that one small branch of a dimorphic form was not dimorphic (p. 12).

The presence of dimorphism is not a question of size; according to Cylkowski, there are both large and small specimens with siphonozooids, and there is no other difference between the dimorphic and monomorphic forms except in the greater extent of the superficial canal system in the former.

Cylkowski confirms Ashworth's statements concerning the relative sizes of the siphonozooids and the young autozooids at the margin of the colony, but says that elsewhere there are intermediate forms which may be siphonozooids in the process of being converted into autozooids, and comes to the conclusion (p. 16) that the siphonozooids are nothing else than developmental stages of the autozooids.

It is noteworthy that no one has yet been able to confirm Kükenthal's statement that there are intermediate forms between those that are dimorphic and those that are not. Thomson and Henderson (1906) and Light (1915), who examined large numbers of Xeniids, found no difficulty in separating the two forms, and I can confirm this from a study of the large collection of specimens I have examined. In my opinion a Xeniid is either dimorphic or it is not; there are variations in the relative numbers of autozooids and siphonozooids, and it is possible that a single small branch of a dimorphic colony may not show any siphonozooids, as in Cylkowski's specimen, although I have not seen one showing this feature, but there is no " beginning of dimorphism," and no intermediate forms between the two. The dimorphism is an established physiological condition in this genus.

The question of the dimorphism in *Heteroxenia elisabethae* seemed to have been definitely settled when Ashworth published his paper in 1899. He showed conclusively that the siphonozooids can be distinguished from the young autozooids of the same height by the size and condition of the tentacles and other characters. He gave the figures of a number of measurements of the two forms, and gave some excellent drawings to illustrate his descriptions (see his pl. 27, figs. 38 and 39).

No serious attempt was made to dispute Ashworth's observations and morphological conclusions until Cylkowski wrote his thesis in 1911. Unfortunately this very interesting paper is not easy to obtain; but thanks to the friendly offices of Prof. Pax I have been able to borrow a copy of the text, without the illustrations, from the library in Breslau.

In most respects Cylkowski confirms Ashworth's results, and indeed emphasizes the difference between the elaboration of the superficial canal system in the dimorphic forms as compared with the monomorphic forms, but states that except at the margin of the capitulum the siphonozooids and the young stages of the autozooids are indistinguishable.

As this is a point of considerable importance I have most carefully examined the

specimen from the Barrier Reef and cannot confirm Cylkowski's result in this respect. Young autozooids and siphonozooids of the same length are quite distinct throughout the whole capitulum. The former can be distinguished from the latter by their greater size, by the presence of pinnules on the tentacles and by the presence of gonads in the coelenteric cavities.

It must be remembered, however, that Cylkowski was working on material from the Red Sea, and it is possible that the difference in our results may be due to a difference in the species that were investigated.

In the controversy on the morphological distinction of the two kinds of zooids, very little attention has been paid to the possible physiological distinction between them.

In other dimorphic Alcyonaria the siphonozooids, having no tentacles and no digestive gland-cells either in the stomodaeum or in the mesenteric filaments, are not digestive zooids; on the other hand, their relatively large siphonoglyph and the retention (usually) of the dorsal mesenteric filaments suggest very forcibly that their main function is to maintain a flow of water throughout the coenenchym. The physiological distinction as regards nutrition is further emphasized in other Alcyonaria by the presence of the six digestive ventral and lateral mesenteric filaments in the autozooids and the absence of these filaments in the siphonozooids.

As Ashworth (1898) was the first to point out, the zooids of the Xeniidae possess no ventral and lateral mesenteric filaments, and in that respect a well-marked morphological distinction between autozooids and siphonozooids does not occur. As compensation for the absence of these mesenteric filaments, however, the stomodaeum of the zooids in this family is remarkably long and the epithelium bears numerous gland-cells, which are probably digestive in functions.

In order to throw some further light on the physiological function of the zooids of *H. elisabethae*, I have examined series of sections through the autozooids and siphonozooids of the very well-preserved specimens from the Barrier Reef.

In 1883 (p. 696), before the days of the modern technique for serial section-cutting, I made the statement that there is no siphonoglyph in the stomodaeum of the autozooids of this species. This was an error, which was corrected later by Ashworth (1899, p. 290). There is a siphonoglyph in the autozooids but it is not so pronounced as it is in the siphonozooids, and in the upper part of the stomodaeum fades away until its epithelium is hardly distinguishable from the epithelium of the rest of the stomodaeum. The mistake I made in my original statement may have been due to the examination of a few sections of the upper part of the stomodaeum in less well preserved material.

It may be noted here that according to Kükenthal (1906, p. 23) there is no siphonoglyph in the autozooids of *Heteroxenia uniserta*.

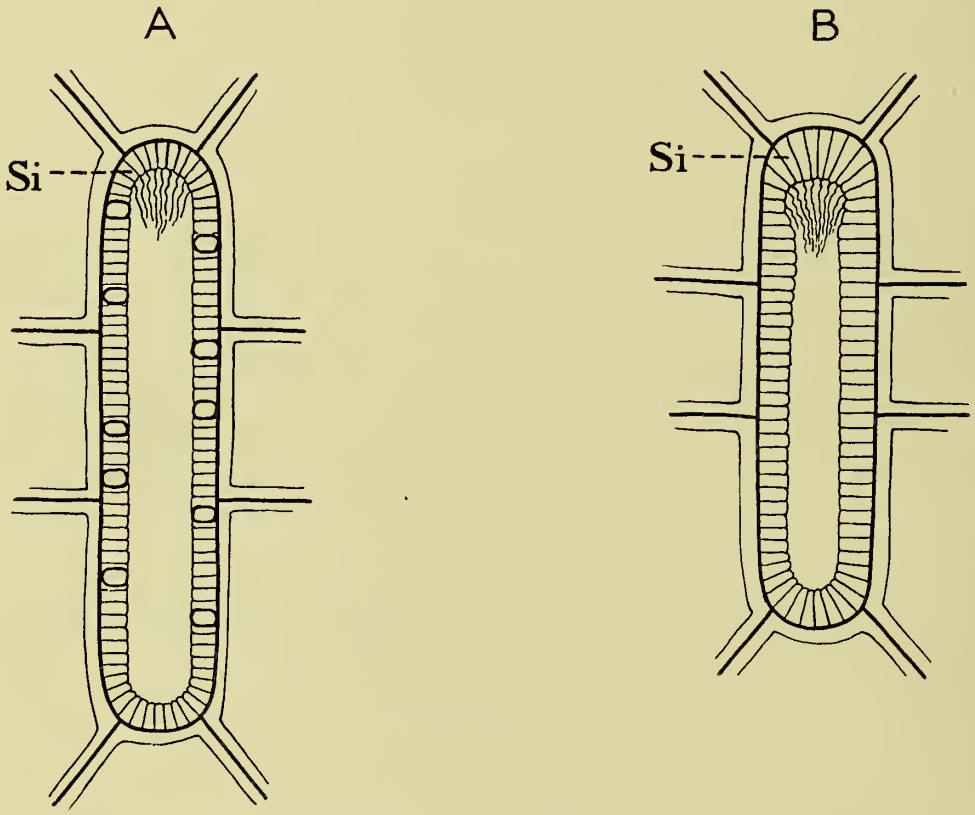
A careful study of series of sections through the whole stomodaeum of both autozooids and siphonozooids of a well-preserved specimen of *H. elisabethae* from the Barrier Reef has led to the following results:

The length of the stomodaeum of the autozooids, according to my measurements, is 3·5 mm. and of the siphonozooids 0·3 mm.

Ashworth (1899, p. 289), working on a specimen from Zanzibar, gave the length of the stomodaeum of the autozooids as 1·15 mm. and of the siphonozooids 0·6–0·8 mm. The discrepancy between the two sets of measurements may be partly accounted for by the fact that in my specimen the stomodaeum was straight and in Ashworth's it was

wrinkled and folded transversely. In both specimens, however, the stomodaeum of the autozooid is much longer than it is in the siphonozooid.

When seen in transverse section the stomodaeum of the siphonozooid appears as a flattened tube 0·2 mm. in greater, 0·055 mm. in lesser diameter (Text-fig. 3). It is lined internally by an epithelium 0·015 mm. in height, but this epithelium becomes thickened to 0·025 mm. in the ventral corner, *i. e.* at the siphonoglyph. The epithelium of the siphonoglyph is not only thicker, but the cells are more crowded together and the nuclei more numerous than they are elsewhere. The cells of the siphonoglyph bear long cilia



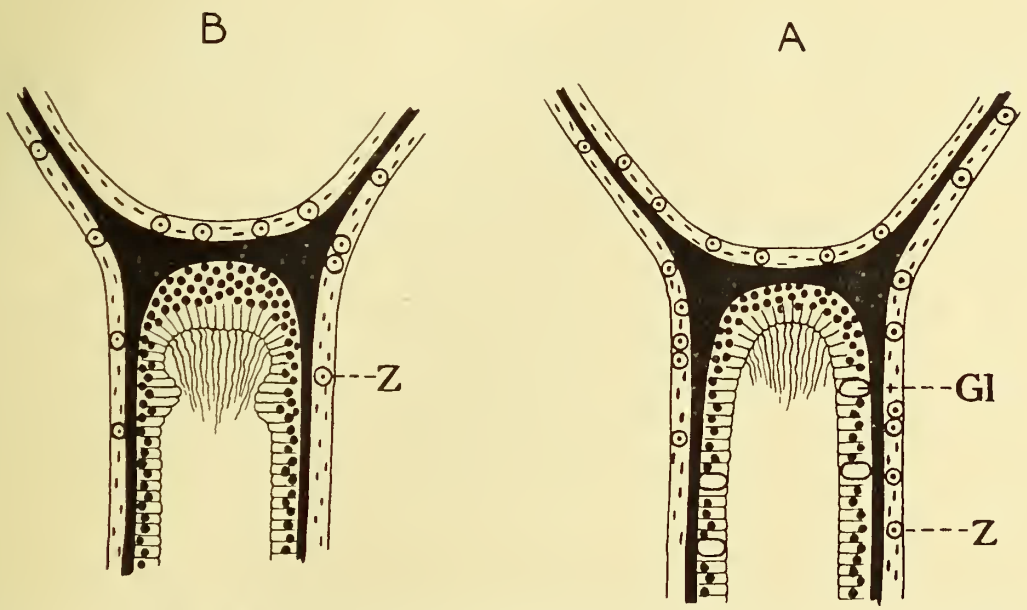
Text-fig. 3.—Transverse sections through the stomodaeum of A, an autozooid, and B, a siphonozooid of *Heteroxenia elisabethae* to show the relative proportions of the siphonoglyph (*Si.*) to the rest of the epithelium. A × 100 diams. B × 200 diams.

which are well preserved in the specimen (Text-fig. 4). The cells of the other parts of the epithelium may also be ciliated, but if present these cilia must be small and are not clearly preserved. The breadth of the siphonoglyph (as seen in transverse section) is approximately 0·03 mm.

In a transverse section of an autozooid the stomodaeum is seen to be more or less folded, but it may be flattened in places as in the stomodaeum of the siphonozooid. The greater diameter of the stomodaeum thus flattened is about 0·5 mm. The epithelium throughout is 0·015 mm. in thickness. In the region of the siphonoglyph the increase in thickness of the epithelium is inappreciable, and the cells do not appear to be much more crowded than elsewhere. But the siphonoglyph is distinguished by bearing a tuft of long cilia as in the siphonozooid.

Taking these figures as approximately accurate, I have reckoned that the proportion of siphonoglyph epithelium to general epithelium, as seen in transverse section, is in the autozooid 1 : 16 and in the siphonozooid 1 : 7. If these figures were to be multiplied by the lengths of the stomodaea of the zooids respectively so as to obtain the superficial areas of the siphonoglyphs and of the general epithelium the contrast would be very greatly increased. This cannot be done at present, as I have found it impossible to determine with any degree of accuracy the length of the siphonoglyph in the two zooids. It is indistinguishable in the upper part of the stomodaeum in the autozooid, and apparently extends throughout its whole length in the siphonozooid.

The structure of the stomodaea of the two forms seems, then, to prove almost conclusively that the siphonoglyph of the siphonozooid is relatively a much more important



Text-fig. 4.—Transverse section through the ventral side of the stomodaeum of A, an autozooid, and B, a siphonozooid, of *Heteroxenia elisabethae* to show the further details of the structure of the siphonoglyph. *Gl.*, gland-cell in the autozooid ; *z.*, zooxanthellae in the endoderm.

organ for maintaining a flow of water than it is in the autozooid. Moreover, as in other Xeniid polyps, the epithelium of the stomodaeum of the autozooid bears numerous gland-cells (Text-figs. 3 and 4) ; in that of the siphonozooid there are none. The siphonozooids, therefore, play no part in catching or digesting food, and their sole function, so far as we can judge, is to produce by the ciliary action of the siphonoglyph a constant flow of water into the canal system of the coenenchym, which the absence of gonads in the coelenteric cavities facilitates.

Haacke, in his account of *Heteroxenia elisabethae* from Torres Straits, said that the siphonozooids are not " professionelle Wasserpumpen." The evidence clearly proves that they are professional water-pumps.

Two other species, *H. capensis* and *H. uniserta*, are unquestionably dimorphic, and another, *H. rigida*, is probably dimorphic. (For the characters of these species see pp. 172, 173.)

The only question that remains, therefore, is whether we are justified in collecting the species of the Xeniidae which exhibit dimorphism into a separate genus. The character is one which can be determined at a glance ; there is never any difficulty in deciding whether a specimen is dimorphic or not. It would therefore be convenient to the systematist to keep them distinct, but apart from that consideration, the morphological investigation of the structure of these species shows that such a separation is scientifically sound.

This conclusion is confirmed by the facts of distribution. In all the localities in which *H. elisabethae* has been found, the Barrier Reef, the Philippines, Zanzibar and the Red Sea, monomorphic species occur living under similar conditions and environment. If dimorphism were due to any extraordinary or special conditions of life, the dimorphic form might be regarded as a variety of a similar monomorphic form specially adapted to survive under these conditions, but as they live side by side on the reefs and do not, so far as we know, give rise to intermediate or hybrid forms, the conclusion that they are quite distinct genetically seems to be inevitable.

The Species Problem in Xenia.—The difficulty of dividing the specimens of *Xenia* into definite specific groups is greatly increased, not diminished, as the numbers examined increase. The discontinuity which seems to occur when only a few odd specimens are studied dwindles and disappears until an almost complete continuity between many of the extreme forms is revealed.

Such an opinion would not have been expressed on the examination of the collection of Xeniids from the Barrier reef alone, rich as it is ; but only after a comparison of them with a large collection from many other localities. It has been my good fortune to be able to examine specimens from the Red Sea, Zanzibar, Diego Garcia, the Maldives, Ceylon, Celebes, Torres Straits, New Britain, Tonga, Fiji and Funafuti, and I have made preparations for the study of the tentacles, spicules and other characters of nearly all of them.

The conclusion I have arrived at is that the keys which have been proposed by Ashworth (1900), May (1900) and Kükenthal (1902), being based on characters which now appear to be very variable, are really of very little value, and that there is a need for a revision of the species of *Xenia*. The remarks that follow, however, have some application to the other genera of the family, and are therefore included in this section.

The principal characters used in the keys are the shape of the pinnules, and the number of them in the oblique and longitudinal rows. If it could be proved that the various shapes of pinnules that are seen in preserved specimens correspond with their shapes when the Xeniids are alive, and that no material change takes place when they are exposed to the sun in shallow water at low tide or when plunged into formalin or spirit, the shape of the pinnules might be of some systematic value. This assumption, however, does not appear to be sound.

The evidence that these Alcyonarians are to some extent contractile is conclusive, and in all probability the pinnules are among the first parts of the polyps to undergo some withdrawal. The number of pinnules in the rows is also assumed in these keys to be a constant character. A statement is often made in the description of a species that the number of pinnules in an oblique row is three or in another species four, as if this was a definite character for all the polyps of the colony. The careful study of a large number of tentacles of any specimen shows, however, that there is considerable variation in this

respect with the species having more than two in a row. Tentacles with 3, 4 or even 5 in an oblique row may be found in one colony (see *H. elisabethae*, p. 171).

I have not found any Xeniid with two pinnules in an oblique row on each side, such as *X. ternatana* is said to have, but I doubt whether they are less variable in that species. Several examples are quoted in the following pages in which the numbers of rows of pinnules are said by previous authors to be variable, and I have found some variation in this respect in nearly all the specimens I have examined.

The shape of the pinnules (pointed cones, blunt cones, warts, mounds, etc.) of preserved specimens is a character due in large measure to the degree of contraction in or before preservation, and is certainly very unreliable for making specific distinctions. Different parts of the same colony often differ very materially as regards the shape of the pinnules. A most striking example of this is described in a specimen of *X. crassa* (p. 160).

Several cases have been quoted of species with pinnules on both sides or all round the tentacles (*e. g. X. bauiana* and *X. medusoides* by May and *X. depressa* by Kükenthal). It is noteworthy that in all these cases the polyps belonged to old Museum specimens. I had not seen any example of it until my attention was called to a specimen collected by Dr. A. C. Haddon, to which a note was attached "dry on arrival." In this specimen several of the tentacles showed wart-like pinnules on both sides.

Unless there is some strong evidence to the contrary derived from the observation of living Xenias or from really well-preserved specimens, this character must be regarded as a result of post-mortem shrivelling.

Kükenthal (1914, p. 6), in the last paper he wrote on the Xeniidae, came to the conclusion that the characters based on the shape and numbers of the pinnules are unsatisfactory for systematic purposes, pointing out that the numbers of rows are often very difficult to count, and that the shape of the pinnules is often due to contraction. With these conclusions I am in full agreement.

If we abandon the use of the tentacles as affording reliable characters for the definition of species, there is nothing left that would help in the formation of a scientific key to the species.

The characters of the stalk are so variable, and seem to be so dependent on the surface of the support and the presence of immediate neighbours, that it has no value.

The spicules in a few cases (*e.g. Cespitularia mantoni*) give examples of discontinuity, but in the great majority of Xeniidae are so uniform in shape, size and variability that they afford no reliable help for distinguishing species.

As regards other anatomical features, such as the mesenteric filaments, stomodaeum canal system, etc., all that can be said at present is that series of sections through several colonies from different localities have revealed a uniformity of structure which gives no clue to any differentiation of species.

It seems probable that the deep-water forms *X. crosslandi*, *X. antarctica* and *X. wandeli* do represent discontinuous groups and are therefore true species.

As regards the forms which are found in shallow water in the Red Sea, Indian Ocean, Malay Archipelago and the Pacific Ocean, there seems to be a continuous series from the forms with large polyps 20–30 mm. in length (*X. elongata*) to those with very small polyps 1 mm. in length (*X. nana*).

It would be quite reasonable to regard them all as varieties of one widespread species adaptable to the very varied environments of warm, shallow sea-waters.

But to give them all one specific name would obviously be inconvenient, and possibly premature.

I have therefore adopted a system based partly on the size of the polyps and partly on geographical distribution—a system which is frankly artificial, but may be convenient as a temporary measure.

Three well-defined genera can be recognized—

1. *Xenia*, with monomorphic polyps. Margin of the capitulum well defined. Stalk, when present, simple or slightly branched, and free from anthocodiae.

2. *Cespitularia*, with monomorphic polyps. Margin of the capitula not well defined. Dendritic or lobate in growth. Stalk and branches with small scattered anthocodiae.

3. *Heteroxenia*, with dimorphic polyps.

4. *Sympodium*. As the species included in the genus *Sympodium* may be only young growth stages of species of *Xenia* there is some doubt as to its validity. The polyps in these forms do not form a syndete but arise independently from a membranous base. Some notes on *Sympodium* are given at the end of this paper (p. 174).

My thanks are due to Prof. Stanley Gardiner for giving me facilities to work in the Zoological Department in Cambridge, to Prof. Pax, of Breslau, for the loan of a copy of Cylkowski's dissertation, to Prof. Ashworth for the loan of an unpublished manuscript on the Dimorphism of *Heteroxenia*, and to several members of the Expedition for information concerning the living Xenias.

The Genus XENIA, *Lamarck*.

It is not necessary to give an account of the very complicated history of this genus. Those who are interested in the subject will find a list of references in the papers by Kükenthal (1902) and previous authors.

There can be no doubt that the Alcyonarian described in MS. by Savigny and published by Lamarck in 1816 was a *Xenia*, and that the type-species of the genus is *X. umbellata*. Since that time a very large number of species have been mentioned or described as species of this genus. Some of these, such as *X. caribaeorum* (D. & M.), are not related to the genus at all (see Kükenthal, 1902, p. 660), and others have been so inadequately described that they cannot be recognized. There remain about 30 species, excluding those which are now referred to *Heteroxenia*, which have been well or moderately well described.

In addition to these there are about a dozen species attributed to other genera, *e. g. Anthelia*, *Sympodium* and *Clavularia* which may be only young growth stages of certain Xenias.

Kükenthal's (1902) definition of the genus was as follows :

> " Mit sterilem einfachem oder getheiltem Stamm und scharf davon abgesetzter Endscheibe. Bei einigen Arten beginnender Dimorphismus der Polypen. Siphonozooide mit Tentakeln aber ohne Pinnulae."

This definition has to be modified as a consequence of more recent researches on the genus.

In the first place there are many specimens which undoubtedly belong to the genus which have no stalk, and in the second place the dimorphic species must now definitely be relegated to the distinct genus *Heteroxenia* (see p. 141).

A revised definition of the genus may read as follows :

Colonies monomorphic. Polyps (*i. e.* the anthocodiae of the polyps) not retractile. Stalk, when present, sharply differentiated from the capitulum, unbranched, or if branched the branches simple and of approximately the same length.

There is never any difficulty in determining whether any specimen of this family is or is not dimorphic. The only species about the dimorphism of which there has been any controversy is *Heteroxenia elisabethae* (see p. 141). In the literature of the subject there is no mention of dimorphism—nor of "the beginning of dimorphism"—in any of the species mentioned in the following lists, and a careful search for any signs of dimorphism in all the specimens of these species I have examined has proved that the colonies are simply monomorphic.

There are no species included in the genus in which the anthocodiae of the polyps are retracted into verrucae or below the general surface of the coenenchym. In this respect they differ from species attributed to the genus *Cespitularia*. But the anthocodiae are to some extent contractile, and in preserved specimens various degrees of contraction may be seen in the body-wall, the tentacles and in the pinnules. In many specimens which undoubtedly belong to the genus *Xenia* there is no stalk—that is to say, the colony is more or less planoconvex in section and the anthocodiae project from the whole of the convex surface.

It is possible, or even probable, that at a later stage of growth these specimens would have developed a stalk, but they must be included in the genus even if it is the case that they never develop this character.

The stalk, when present, is thick and either simple or in some cases divided into a few short branches, but the capitula at the ends of these branches are so close set that the colony appears to have only one capitulum. In *Cespitularia* the branches are discrete. (Plate II, fig. 6).

There can be little doubt that in some Xenias there are no spicules, but when they are present they are thin discs or ovals having a maximum diameter of 0·018–0·025 mm. In some cases rods and twins occur with the common types, but the shape of the spicules is so variable that they are rarely of any value for specific diagnosis. A point of some interest about them, however, is that they are very rarely over 0·025 mm. or less than 0·018 mm. in diameter. The largest I have seen are curiously enough in the very small specimens of *X. nana* (Hickson, 1931), where the twins are 0·05 mm. in length.

Geographical Distribution.—The genus has a wide distribution in shallow tropical seas, extending from the Red Sea through the Indian Ocean, Malay Archipelago and Australian Barrier Reef to the western half of the Pacific Ocean. Kükenthal's *X. antarctica* was found in 457 metres off Bouvet Island, and Jungersen's *Ceratocaulon wandeli*, which is probably a *Xenia*, was found in 538 metres in the Arctic Sea N. 66° 16′, W. 25° 20′.

No species of the genus have been found in the Atlantic Ocean nor in the Pacific Ocean east of longitude 180°, unless the *Sarcothela edmondsoni* (Verrill, 1928) of Hawaii proves to be a *Xenia*.

From the shallow waters off the coast of Zanzibar ten species have been described as distinct, from Ternate eight species, and from various localities in the Pacific Ocean nine species.

In many cases a new species has been named on the description of only one or two specimens from a locality and on characters which we know now are extremely variable, and there can be no doubt that if such characters are used in the same way for specific diagnosis, the number of species of the genus will be extended indefinitely.

The work of the past is not to be regretted because the description of a new species is almost invariably more detailed and better illustrated than the description of a specimen referred to an established species. We have at least learned a great deal by this process of the variations within the genus. But it is incredible that in the shallow waters of the coast of Zanzibar, for example, there are ten true Linnean species. Some may be only young growth stages, some varieties due to purely local conditions, and others may possibly be hybrids.

It may be premature to act upon the belief that specific differentiation does not exist in the genus, or that there is only one very variable species in the world, but some reduction in the number of recognized species must be made unless the systematics of the genus are to be thrown into absolute confusion.

It may be most convenient to deal with this matter geographically in the first instance.

Red Sea.—Three species have been described from the Red Sea : *X. umbellata*, *X. fuscescens* and *X. coerulea*. The monomorphic forms of *X. fuscescens* are so closely allied to *X. umbellata* that it is impossible to separate them (see p. 173), and as Thomson and MacQueen (1908, p. 51, footnote) remark, " it seems certain that *X. umbellata*, *X. fuscescens* and *X. coerulea* are very closely related. It may be necessary eventually to unite them in one variable species."

To these species May (1900, p. 81) added *X. blumi* (Suez) and Kükenthal (1913) *X. ternatana* (Jedda) and *X. hicksoni* (Massowa) as inhabitants of the Red Sea. Kükenthal's two specimens of *X. hicksoni* differ from the type in having much bigger polyps and smaller spicules. The description is not very full, and the specimens may be only a variety of *X. umbellata*.

Zanzibar.—The following species have been recorded :

X. umbellata.
X. tumbatuana.
X. quinqueserta.
X. sansibariana.
X. bauiana.
X. medusoides.
X. coerulea.
X. membranacea.
X. ternatana.
X. crosslandi (*rigida*).

In *X. bauiana*, according to May (1900, p. 77), there are three rows of pinnules on each side of the middle line on both sides of the tentacles. *Xenia quinqueserta* and *X. sansibariana* are evidently closely related, from May's original account, the only difference between them being that the pinnules are thick and blunt in the former and long and pointed in the latter. They are both said to possess five rows of pinnules, but in a specimen attributed to *X. quinqueserta* by Thomson and Henderson (1906) there are said to be three to five rows of pinnules, and these authors remark, " we suspect that both may be varieties of *X. umbellata*."

X. tumbatuana (May) seems to me a very doubtful species. It has three rows of thick blunt pinnules on the tentacles, but in other respects does not differ materially from the other two species.

No spicules were found in any of the three species mentioned above.

X. medusoides (May, 1900, p. 88) was described from two specimens in the Hamburg Museum. The only distinguishing feature of this species is that the pinnules are arranged all round the slender axis of the tentacles. I have frequently found this condition in shrivelled, badly-preserved specimens, and it is difficult to believe that it is anything but an artefact. This view is confirmed by the description (by Kükenthal, 1902, p. 656) of another specimen in the Stuttgart Museum in which the pinnules were strongly contracted. The only case in which I have observed rows of pinnules on the aboral side of tentacles that are apparently fully expanded is that of *X. garciae.*

X. membranacea was first described by Schenk (1897, p. 57) from Ternate, and specimens were afterwards attributed to the species by Ashworth (1900, p. 512) from New Britain and by May (1900 p. 86) from Zanzibar. The accounts of this species are by no means in agreement, and it is difficult to determine what are its distinguishing features. The name implies that there is a membranous expansion of the base, but this is only an adaption to the habit of growing on branches of corals. The pinnules of the tentacles are arranged in three or four rows according to Schenk, in four rows according to May, and in six rows according to Ashworth, but in all cases the lower end of the axis of the tentacles only is free from pinnules.

X. ternatana was originally described by Schenk (1897) from Ternate. A specimen from Zanzibar was referred to this species by Thomson and Henderson (1906, p. 412) on the ground that it has only two rows of pinnules. In many other respects it diverges from the type. The polyps are much larger than they are in the type and agree more closely with those of a typical *X. umbellata*, but if there are only two rows of pinnules they differ from this species to a very marked degree. It is often difficult to determine whether there are three or four or five rows of pinnules on the tentacles of the Xenias on account of contraction leading to overcrowding; but it should not be difficult to determine that there are two rows and not more than two rows. *X. ternatana* might stand, therefore, for the present as an independent species, but a more elaborate and detailed account of its tentacles is very desirable.

Xenia rigida (Th. and H., 1906, p. 413) must not be confounded with May's species of the same name. Kükenthal (1914, p. 8) has suggested that the name be changed to *Xenia crosslandi.* It was found in 10 fathoms of water. The species appears to be quite distinct as it has remarkably large (0·06 × 0·08 mm.) " rod-like " spicules. *X. coerulea* is almost certainly a young stage of *X. umbellata.*

Summary.—In the Zanzibar region there occurs one very variable species, *X. umbellata*, one doubtful species, *X. ternatana*, and in deeper water one species, *X. crosslandi.*

Indian Ocean.—There is a well-defined species *X. garciae* (Bourne, 1895, p. 475) which is found in Diego Garcia and other reefs, *e. g.* Egmont reef, Addu Atoll and Hulule Male Atoll (Hickson, 1903, p. 479) in the Indian Ocean.

The polyps in this species are small, the body-wall being from 1·5–3 mm. in height, and the pinnules of the outer row of the tentacle almost meet on its aboral surface. The spicules are spherical or oval but smaller than usual—0·01–0·02 mm.—and very irregular in outline in the type-specimen.

X. nana from Ceylon is an even smaller species (Hickson, 1931), with only a single row of pinnules on each side of the tentacles. Some of the spicules are larger than usual, and it therefore seems to be quite distinct from *X. garciae.* But this species may be only a juvenile form of a larger one. A small form of *X. umbellata* has also been described from

Diego Garcia by Bourne, and specimens of *X. ternatana* and *X. umbellata* from Ceylon by Thomson and Henderson (1905, p. 273).

Malay Archipelago.*—Schenk (1896) described eight new species of *Xenia* from Ternate. Two were described from the examination of two specimens each and six from one specimen each.

There are many respects in which these eight species resemble one another. The length of the polyp body is 4–7 mm. except in *X. rubens*, where the figures given by Schenk are 6–11 mm. They have all with the exception of *X. ternatana* three pinnules in an oblique row on the tentacles, and they all bear spicules of the usual type of approximately the same size, *i. e.* about 0·02 mm. in diameter. The differences between them are mainly differences in the size and characters of the pinnules of the tentacles and in the form of the stalk, when present.

As these characters are very variable, it seems probable that all these species from Ternate are really forms of only one species, and that this species may be difficult to distinguish from *X. florida* of Dana. It may be premature to lump all these species into one at present, but the number should, in my opinion, be considerably reduced.

Xenia ternatana stands by itself in having only two rows of pinnules, a character which should be clearly recognizable even in preserved specimens from the three to four rows of pinnules in the other species. It would, however, be of great interest if it could be definitely known that in the specimens attributed to this species there are never more than two pinnules in a row in any of the tentacles.

X. plicata seems to be distinguished from the others by a greater degree of contractility of the pinnules and the remarkably long slender tentacles.

X. crassa, *X. fusca*, *X. membranacea*, *X. viridis* seem to me all variants of one species which should be called *X. crassa*.

X. blumi is closely related to *X. plicata*, with which it was found associated, and so is *X. rubens*, although according to Schenk's statement it has much shorter tentacles and on that account may be distinct.

The species from Ternate may therefore be reduced to three—*X. ternatana*, *X. plicata* and *X. crassa*—with two doubtful species, *X. blumi* and *X. rubens*.

Kükenthal (1911) attributed specimens found in 3–4 metres in the Kei Archipelago to the species *X. florida* and *X. viridis*. He does not give a full account of them, but according to his key plan (1902) *X. florida* should have two rows of pinnules and *X. viridis* three.

Dana (1848) described a species, *X. elongata*, from Amboyna with exceptionally large polyps (20–30 mm. in height). There is a piece of a colony in my collection from Celebes which resembles *X. elongata* in the exceptional size of the polyps and other respects. No mention is made by Dana nor by Wright and Studer of spicules in this species. In my specimen they are absent.

I am inclined to think, therefore, that *X. elongata*, Dana, should stand, for the present, as a distinct species.

Xenia hicksoni is the name given by Ashworth (1899, p. 245) for a single specimen from Celebes. It may prove to be only a local variety of *X. umbellata*, which it resembles in the general form of the colony, but it differs from that species in the smaller size of the polyps and in some other respects.

Pacific Ocean.—The coast of New Britain seems to yield a rich harvest of Xenias.

* See Appendix, p. 177.

Ashworth (1900) described a new species, *X. novae-britanniae*, and referred other specimens to the species : *X. umbellata*, *X. membranacea*, *X. crassa* and *X. viridis*.

For reasons clearly stated by Ashworth (p. 521) *X. novae-britanniae* must stand as a distinct species. It was founded on the examination of eight specimens, all of which can be readily distinguished from the other species in the same region. The principal character is the relatively small size of the polyps.

The New Britain specimen of *X. umbellata* differs from the Red Sea type in some respects, but is correctly referred to that species. The other three should in my opinion be all referred to *Xenia crassa*.

A *Xenia* from New Ireland was described by Lesson under the name *Actinantha florida*. According to Kükenthal (1902, p. 647) this species is distinct from *X. danae* of the Fiji Islands, with which it was formerly confounded, in having only two rows of pinnules on each side of the tentacles. It is quite impossible to be certain of the characters of these two species described long ago by Lesson and Dana. Dana considered that his species from Fiji was identical with Lesson's species from New Ireland. Verrill (1869, p. 283), who had the advantage of examining all Dana's types, said he could see no difference between his specimen of *X. florida* and *X. umbellata*. Gray included Lesson's *Actinantha florida* in his genus *Loridella*, which has " fusiform spined spicules." Kükenthal (1902, p. 468) described a specimen from Port Denison under the name *X. florida* and states that it has only two rows of pinnules on each side of the tentacle, but gives no information as to the presence or absence of spicules.

It can lead to nothing but confusion if we try to retain these two species. We may take Verrill's opinion that *X. danae* is identical with *X. umbellata*, and relegate *X. florida* to the list of species that are imperfectly described.

Kükenthal (1914, p. 9) described a new species, *X. multispiculata*, from Fiji and Tonga. This species is clearly related to *X. crassa*, but differs from it in the greater size of the polyps (9–16 mm. in body length) and the larger number of pinnules in a longitudinal row (26–30). I have some specimens from Tonga collected by Mr. J. J. Lister which are more closely related to *X. crassa* as regards measurements, but in other respects resemble *X. multispiculata*.

I have also a most instructive series of ten specimens collected by Prof. J. Stanley Gardiner at Funafuti in the Ellice Group. There can be little doubt that they all belong to the same species, but, as they show various stages of contraction, they form a series which connects the more typical varieties of *X. crassa* with the description of *X. multispiculata*. In some specimens the pinnules are low warts, in others they are long and slender with a length of 0·75 mm., and in some cases both kinds of pinnules with intermediates are found in polyps of the same colony.

However, I have not found any tentacle with more than 16–18 pinnules in a longitudinal row, and the number in an oblique row is 3–4, not 2–3, as in *X. multispiculata*. There may be, therefore, a specific distinction between them.

In all the specimens from Tonga and Fiji I have examined the spicules are very numerous and crowded on the tentacles and pinnules, and most of them are discs with a diameter of about 0·02 mm. The spicules of *X. multispiculata* are said to be oval in shape with greatest diameter of 0·015 mm.

Australia (including Torres Straits).—The Xeniid fauna of the Great Barrier Reef was described by Saville-Kent (1893, pp. 196–198), but unfortunately the four species that

he named were never worked out in detail or clearly defined. He mentions a specimen of *X. elongata* with polyps half an inch (12·5 mm.) in diameter, and three other species which he could not identify—*X. pulsitans*, *X. ochracea* and *X. brunnea*. As his systematic work was so incomplete, some important and very interesting notes on the natural history of the species seem to have been generally overlooked by subsequent writers.

He laid great stress on the difference between the Xenias with fringed tentacles (*e. g. X. pulsitans* and *X. brunnea*) and those with tentacles that are minutely warted (*X. elongata*, and *X. ochracea*), and suggested that the latter should be placed in a distinct genus, *Paraxenia*.

He gave a detailed account of the colours of his four species, showing that there is a great diversity in the colour of specimens which he considered to be representatives of distinct species. A remark he made on the specimen found off Warrior Island, Torres Straits, which he called *X. pulsitans* is of special interest (*l. c.* p. 197). He said that it has expanded tentacles over an inch in diameter, and that "all the eight tentacles move synchronously, opening out and contracting in a continuous measured rhythm—like the pulsating contractions of a jelly-fish."

This extraordinary behaviour of a *Xenia* seems to be similar to that of a grey *Xenia* of the Red Sea, which Dr. Crossland informs me in a private letter, recently received, "rapidly opens and closes its tentacles."

The only other record of a species from this region is that of *Xenia florida* off Port Denison (Kükenthal, 1902, p. 648).

On the western side of Australia (Abrolhos Islands) there is a record by Miss Thorpe (Mrs. Hunter) of three varieties of *Xenia*—*X. blumi* var. *pelsarti*, *X. ternatana* var. *littoralis*, and *X. depressa* var. *kükenthali*. The principal difference between these varieties is in the characters of the pinnules; in other characters they are very much alike; and although we are grateful for a very full and careful account of the characters of the specimens, there may be still some doubt whether they are not varieties of only one species.

Antarctic Ocean.—*Xenia antarctica* was obtained by the Valdivia expedition at a depth of 457 metres east of Bouvet Island and described by Kükenthal (1906, p. 19). It has large polyps (10–12 mm. in length) and no spicules. It is distinguished from all the other species with large polyps in having only one longitudinal row of 14 pinnules on each side, and a number of very low wart like processes scattered irregularly on the oral surfaces of the tentacles.

X. depressa was described by Kükenthal (1914, p. 6) from a specimen in the Vienna Museum. It was said to be related to *X. bauiana* (May).

Arctic Ocean.—Jungersen (1892) described an Alcyonarian from 538 metres, N. 66°16′, W. 25°20′, under the name *Ceratocaulon wandeli*. According to Kükenthal (1906, p. 22) this is a *Xenia* closely allied to *X. antarctica*.

The list of species of *Xenia* as amended is as follows:

1. *Xenia umbellata*, Ehrb.

This species is widely distributed in the Red Sea, Indian Ocean, Malay Archipelago, Australian Barrier Reef and Pacific Ocean. It has large polyps and a low degree of contractility. Spicules absent or present. It includes the following as synonyms: *X. fuscescens*, Ehrb., *X. coerulea*, Ehrb., *X. bauiana*, May, *X. sansibariana*, May, *X.*

tumbutuana, May, and *X. quinqueserta*, May. *X. medusoides*, May, and *X. depressa*, Kükenthal, are probably varieties of this species.

2. *Xenia elongata*, Dana. Malay Archipelago.

This species has very large polyps. Spicules absent.

3. *Xenia hicksoni*, Ashworth. Celebes.

This species may be a variety of *X. umbellata* but it has smaller polyps.

4. *Xenia plicata*, Schenk. Malay Archipelago and Australian Barrier Reef.

This species has smaller polyps than *X. umbellata* with relatively long tentacles. Numerous spicules.

X. blumi and *X. rubens* of Schenk may be regarded as synonyms of this species.

5. *Xenia crassa*, Schenk. Malay Archipelago, Barrier Reef and Pacific Ocean.

This species has smaller polyps and relatively shorter tentacles than *X. plicata*.

X. fusca, *X. viridis* and *X. membranacea* of Schenk are probably synonyms of this species. For further considerations of the relations of *X. plicata* and *X. crassa* see p. 156.

6. *Xenia multispiculata*, Kükenthal. Fiji and Tonga. This species has larger polyps than *X. crassa*, but seems to be related to it.

7. *Xenia garciae*, Bourne. Indian Ocean. This species has small polyps (1·8–3·5 mm.), and the outer rows of pinnules almost meet on the aboral side of the tentacles.

8. *Xenia novae-britanniae*, Ashworth. New Britain. This species has larger polyps (2·8–3·5 mm.) and larger tentacles than *X. garciae*, and the outer rows of pinnules are widely separated on the aboral side of the tentacles. (See Ashworth, 1900, p. 520.)

9. *Xenia ternatana*, Schenk. Ternate, Zanzibar ? and Ceylon.

This species is said to differ from all the species mentioned above in having only two longitudinal rows of pinnules.

10. *Xenia nana*, Hickson. Ceylon.

This is a dwarf species with very small polyps and only a single row of pinnules on each side of the tentacles.

The following species were found in deep water and seem to be quite distinct (see pp. 151, 154).

11. *Xenia crosslandi* (*X. rigida* of Thomson and Henderson) off Zanzibar.

12. *Xenia antarctica*, Kükenthal. Antarctic Ocean.

13. *Xenia wandeli*, Jungersen. Arctic Ocean.

The following species have been so inadequately described that their correct identification is impossible : *Xenia florida* (Lesson), *X. danae* (Verrill), *X. samoensis* (Studer), and *X. ochracea*, *X. brunnea* and *X. pulsitans* (Saville Kent).

The study of the large collection of specimens of this genus from the Barrier Reef has made the task of arranging them in clearly defined specific groups extremely difficult. The characters that have hitherto been used for systematic purposes have proved to be so variable that they are almost useless, and any system based upon them must be provisional and artificial.

Taking a general view of the collection, there seems to be a rough grouping into three sets :

(1) Those with large polyps (8–10 mm. in body length) and relatively feeble powers of contraction, which I have referred to *X. umbellata* (Ehrb.)

(2) Those with smaller polyps (6–8 mm.) relatively long tentacles (4–6 mm., and greater powers of contraction, which I have referred to *X. plicata* (Schenk).

(3) Those with still smaller polyps (4–5 mm.) and relatively shorter tentacles (2–5 mm.) and still greater powers of contraction, which I have referred to *X. crassa* (Schenk).

There is naturally some overlapping between these groups, and there are some specimens that it is difficult to place definitely in any one of these species, but unless the extreme step is taken of lumping them all into one very variable species, this plan seems to me the only one that can be adopted.

The characters I have given of *X. plicata* and *X. crassa* do not agree entirely with the account of these species given by Schenk, but the illustrations he gives of them in his plates ii and iii do represent the differences between the groups in this collection which seem to prevail.

The specimens in the groups agree in having numerous discoid or oval spicules 0·02–0·025 mm. in size and in having 3–4 pinnules in an oblique row. In *X. umbellata* 4 pinnules in these rows is not uncommon, in *X. plicata* 4 pinnules occasionally occur, in *X. crassa* there are very rarely more than 3 pinnules. I have not seen any tentacle with two pinnules in a row or more than four.

The number of pinnules in each longitudinal row is very variable. In the larger polyps of *X. umbellata* there are 24–29, in *X. plicata* 18–22, in *X. crassa* 12–18.

Xenia umbellata, Ehrenberg.

There are two specimens collected at A 4′ south of the anchorage on Low Isles which I have referred to this species.

The striking features about them are the relatively larger size and comparatively feebler contraction of the polyps than in the others, and by their superficial resemblance to the specimens of *Heteroxenia elisabethae* from the Wishart's reef close by.

They are not dimorphic and neither of them shows at the margin any young polyps devoid of pinnate tentacles. In this respect, then, they are quite distinct from *Heteroxenia*.

The difference between them and some of the specimens I have referred to *X. plicata* is not so clearly defined, but they differ from them in having larger and stouter polyps, longer and wider tentacles, longer pinnules and fewer spicules in the body-wall. The two specimens were labelled α and γ respectively by the collector. Specimen α seems to be fully expanded; specimen γ shows some contraction of the tentacles, which, instead of being straight and outstretched, are bent over the oral disc. The latter therefore looks more like some of the specimens of *X. plicata* than the former.

Specimen α.—Springing from an irregular base (about 25 mm. in length), with a wide membranous expansion attached to an old coral branch, there is a low capitulum (ca. 60 × 25 mm.) with a stalk visible on one side only about 5 mm. in height.

The polyps are fully expanded, showing no contraction of the body-wall, and the pinnules even on the smallest polyps are slender and pointed cones. The larger polyps in the centre of the capitulum have a body-length of 10 mm. and the tentacles are 6 mm. in length. It is difficult to count the number of pinnules in an oblique row, but the usual number is three. There are four in some places, but never less than three. There are about 25 in each longitudinal row.

The spicules are very numerous in the tentacles, including the pinnules, but in the body-wall they are much more scattered than in *X. crassa*. They are mostly round in outline and ·02 mm. in diameter, but there are a few ovals slightly larger than this in one diameter. They have a pale orange colour.

Specimen γ.—This specimen has a very small base, 15 mm. in diameter, detached from its support. From the base rises a stalk which divides almost immediately into four branches. In the longest of these branches the distance of the capitulum from the base is 25 mm. The total width of the four capitula together is about 40 mm.

The difference in form of the two specimens is very striking, the one with a wide spreading base and a very short or no stalk and the other with a small base and long stalks. This difference is probably only due to the adaptation of growth of the colony to the support on which the larva happens to have settled. If a colony can spread at its base it does so and grows laterally, but if the support is small it has to grow in height and form a stalk or stalks.

The largest polyps are 10 mm. in height but the tentacles are shorter than in α, the longest I have measured being only 5 mm. in length. The pinnules are all long and pointed, and arranged as in α in oblique rows of three or four. The number in a longitudinal row is only 18.

The spicules are similar to those of α, very numerous in the tentacles, scattered in the body-wall. There seem to be rather more ovals than in specimen α, but the majority are round and a little smaller than in *X. crassa*.

These specimens were collected on April 24th, 1929. Gonads were not present.

Xenia plicata, Schenk. (Plate II, fig. 5.)

This species was described by Schenk from a single specimen growing on a madrepore branch at Ternate.

In the Great Barrier Reef Expedition collection there are five specimens from Low Isles and some others from Maer Island and Batt Reef, which resemble most closely the type of this species, but, as some of them show variations from the type, they afford interesting material for the determination of characters which are variable, and therefore of little value for systematic purposes, and characters which are less variable or invariable.

According to the short definition of the species given by Schenk (1897, p. 67) the colony is in the form of a thick stem with a slight concave upper end from which the polyps arise. The long tentacles bear three rows of short round wart-like pinnules on each side and the axis of the tentacles is free from pinnules throughout its whole length. There are 18–22 pinnules in each row. The numerous spicules scattered throughout the colony are discs which measure from 0·015–0·02 mm.* in diameter.

The form of the colony seems to be useless as a specific character, as in this collection there are specimens with a simple stalk as in the type, a divided stalk, a very short stalk and no visible stalk.

The length of the tentacles of the full-grown polyps, the number of rows of pinnules and the number of pinnules in each row are fairly constant characters. The spicules are variable in shape as between rounds and ovals. The pinnules of this and other species

* In the text the figures given are 0·015–0·2 mm. I think the latter must be a misprint for 0·02 mm. The largest spicules in any Xeniid hitherto described are only 0·1 mm. in diameter.

of *Xenia* are described by Ashworth and Schenk as " warts " to distinguish them from the long slender pinnules of *X. umbellata* and other species, and these authors divide the species into three groups : I, with long slender pinnules ; II, with slender pinnules and warts ; III, with warts only.

The difficulty I had in determining the position of these Xeniids was that, although in the majority of the tentacles the pinnules were all warts, in some a few pinnules were long and pointed. The question then was, Do they belong to division II or III of Schenk's system ? In all other characters they are most closely related to *X. plicata*, which is placed by Schenk in division III.

There is no account of the appearance of these tentacles in the living specimens, but it is probable that in a healthy and fully expanded condition the pinnules are all or nearly all long and slender.

Description of the Specimens.

1. The Specimens from Low Isles.—Specimen A : The stalk arises from a base 20 mm. in diameter, and at a distance of 22 mm. from the base it divides into two branches. One branch has a maximum height from the base of 33 mm. and the other of about 30 mm. Both end convexly, and the expanded polyps of the two branches mingle to form what appears to be a single capitulum about 55 mm. in diameter.

The body of the larger polyps is 6 mm. in length and approximately 1 mm. in diameter when the polyps are fully expanded. The tentacles are very uniformly 6 mm. in length. The pinnules are arranged in oblique rows of three, and there are 18–20 pinnules in each row. The character of the pinnules varies a great deal. In most of the tentacles they are short round or dome-shaped warts. They vary so much in size in different tentacles and parts of the same tentacle that it is impossible to give a measurement of general application. In the middle of the tentacle a typical wart is about 0·15 mm. in height and 0·18 mm. in diameter. In some of the tentacles, however, there are pinnules which are slender and pointed at the extremity with a length of 0·4–0·6 mm. Between these and the ordinary warts every intermediate condition can be found. On the oral side of the tentacles there is a bare space between the pinnules which extends from the base almost to the extremity.

Specimen B : The base of this specimen is hour-glass-shaped, 32 mm. long by 10 mm. broad in the constricted part and 20 mm. broad in its widest part. From the base four very short stems arise, giving rise to a common capitulum 60 mm. in length. This specimen seems to be less contracted than the specimen A, the polyps are longer (5–7 mm. in height) and the pinnules are 4 in a row in the middle of the tentacles, 3 at the base and apex.

Specimen C is a long straggling colony 80 mm. in length with several bases of attachment. The greater part of it has no stalk, but at one end there is a stalk 12 mm. in height. The polyps resemble those of A more closely at one end and those of B at the other.

Specimens D and E are smaller than the others and have rather more contracted polyps.

Spicules are present in all these specimens and round or oval corpuscles approximately 0·02 × 0·025 mm. in size. They are found in large numbers throughout the superficial parts of the colony, including the tentacles and pinnules.

2. A specimen (Plate II, fig. 5) from Batt Reef, Patch 1, 7 miles E. of Low Isles, presents some difficulties. It is smaller than the others, and in some respects resembles *X. crassa*, suggesting that the separation of these species is artificial.

It differs from the specimens of *X. crassa* described in this paper in having relatively

long tentacles and larger spicules, mostly ovals. From a membranous expansion at the base there rises an undivided stalk expanding above into a capitulum 50 mm. in diameter.

The body of the polyps is 4–5 mm. in height and the long slender tentacles 4 mm. in length. The pinnules are blunt pimples about 0·3 mm. in length, *i. e* they are intermediate between low warts and the slender pointed pinnules. There are 3 pinnules in the oblique rows and about 16 in the longitudinal rows.

3. The specimens from the N.W. reef flat of Maer island (11th May, 1929) are most difficult to describe and to identify, but afford an instructive study of variation in the genus.

On a dead coral branch about 120 mm. long there are several patches of *Xenia* polyps, united in many places by a thin membranous expansion of the base which spreads over the coral. Only in one place can anything of the nature of a stalk be seen, and the greatest height of this on one side is only 4 mm. This place shows, when cut through, a typical syndete 7 mm. in height. Elsewhere the polyps seem to arise directly from the membranous expansion. The continuity of these clusters proves almost conclusively that we are dealing here with one species, but it is impossible to say for certain whether the whole series is the product of one larva.

The size and structure of the polyps vary so much in different parts of the clusters that a single definite statement on either of these features, such as could be given in a table, cannot be made.

On the edges of the clusters and standing isolated on the stolon there are some very small polyps. These are not siphonozooids, as they show the full complement of 8 small tentacles bearing wart-like pinnules.

One of the largest polyps was removed for examination from the middle of one of the clusters. The length of the body is 8 mm. and its diameter 0·4 mm.; the tentacles are 4 mm. in length. The pinnules in these tentacles are principally warts, but there are some conical or pointed ones at the extremity with a length of 0·2 mm. The arrangement of the pinnules in rows is difficult to determine, owing to a transverse constriction of the tentacles, the rows, particularly at the distal end, becoming distorted and confused. At the basal end of the tentacles there are clearly 3 wart-like pinnules in each oblique row, but at the distal end there can be clearly seen 4 pinnules in some of the oblique rows. The exact number of pinnules in the longitudinal rows is also very difficult to determine, but there are at least 20, and perhaps a few more in the outer row. The bare track between the rows of pinnules on the oral side of the tentacles is clearly seen over the proximal half, but is greatly constricted distally.

Selecting the largest polyps from another cluster I obtained different results. The body of the polyps is 6 mm. in length and nearly 1 mm. in diameter, the tentacles were 5 mm. in length, and nearly all of the pinnules of the outer longitudinal row are long pointed cones and up to 0·3 mm. in length.

The spicules are abundant in the ectoderm of body, tentacles and pinnules. They vary in shape from round to oval. The size of the larger discs is 0·025 mm. in diameter and of the ovals 0·02 × 0·025 mm.

On further examination of several polyps and their tentacles I have come to the conclusion that no specific difference can be established between these specimens and those from Low Isles.

In the spirit specimens the Maer Island variety seems to have relatively shorter tentacles and rather more pinnules in each longitudinal row. The pinnules may be a

little more contractile than in the Low Isles specimen, but no material differences can be seen in the size, shape or distribution of the spicules or in other characters of the polyps.

The spreading membranous expansion and almost complete absence of a stem are, in my opinion, characters of no specific importance, but dependent entirely upon age, the nature of the support and the conditions of the environment.

Xenia crassa, Schenk. (Plate II, fig. 4.)

A number of specimens collected by the expedition are most conveniently grouped together in the species *Xenia crassa* as amended above (p. 155). They may be described under the letters O, P, Q, R, S.

They were all found in shallow water off Low Isles. P and Q were found in the glades of the mangrove swamp, O and R on the Luana reef and S on the opposite side of the anchorage.

It is worthy of note that P and Q from the mangrove swamps have retained a pale blue colour. The others, which we may suppose were more exposed to the sun, are white or pale yellow.

As there is no information on the labels on the colour of these Alcyonaria when collected, I do not think this difference can be of any specific interest. All of these specimens were carefully examined, and a table constructed of their measurements and other characters.

They all had three oblique rows of pinnules, except that in some tentacles of Q there was a fourth in the row in the middle of the tentacle. The number of pinnules in each longitudinal row, which was very difficult to count in some cases, varied from about 12 to 18 but did not exceed 18.

In all the specimens there were numerous spicules in the body-wall, axis of the tentacles and in the pinnules. They were round or oval in shape, and varied from 0·015 to 0·02 mm. in size.

In other characters there were wide variations, so wide indeed that under the old system several distinct species would be proposed for them. The specimen Q from the mangrove swamp afforded a most instructive example of what the range of variation in a species may be in preserved specimens.

This specimen is attached to a branch of dead coral. It consists of two capitula connected together by a thin band 12 mm. extending from the membranous expansion of the base. The capitula are 30 mm. and 23 mm. respectively in diameter. There is no stalk at the base of either capitulum, but the syndete in the larger one is about 4 mm. thick in the middle.

There can be no doubt whatever that the two capitula are parts of the same colony, and yet the polyps differ from one another to a remarkable extent, as shown in the following table:

	Diameter.	Body length of polyps.	Length of tentacles.	Pinnules.
Capitulum I	30 mm.	8 mm.	5·5 mm.	0·45 mm., long and pointed
Capitulum II	23 ,,	2·5 ,,	2 ,,	Very low warts.

These are measurements of a typical polyp taken from the centre of each capitulum, but a critical examination of the larger capitulum shows that there are several smaller polyps near the margin with low wart-like pinnules as in the smaller capitulum.

This specimen also throws light on some other characters which have been used for the determination of species. Schenk and May give as a distinguishing feature of *X. rubens* that there are five or six irregular rows of little warts scattered over the inner side of the tentacles, and May characterizes *X. bauiana* and *X. medusoides* by having pinnules on both sides of the tentacles. Both these conditions are found in some of the polyps of this specimen. In the fully expanded tentacle the outer longitudinal row of long pointed pinnules is always on the edge of the tentacles, the aboral surface being quite free. In the polyps that are more contracted the wart-like pinnules appear to be scattered irregularly on the oral side of the tentacles ; and in some of the most contracted tentacles pinnules seem to be irregularly arranged all round the axis, as they are said to be in May's *X. medusoides*. It is true that in *X. bauiana* and *X. medusoides* the pinnules are said to be long and slender, whereas in these forms they are usually wart-like in shape ; but the great variety in the forms of pinnules in specimen Q leads me to the conclusion that the appearance of pinnules on the aboral side of the tentacles is always caused by contraction. The specimens I have attributed to this species from the Barrier Reef were as follows :

Specimen O : This specimen has a capitulum 42 × 38 mm. There is a short stalk not exceeding 10 mm. in height springing from an almost circular compact base (25 mm. in diam.). The polyps are densely crowded and somewhat contracted. The body length is about 5 mm., the tentacles 4 mm. in length, the pinnules of some of the polyps long (0·3 mm.) and pointed. The spicules have a pale orange colour. The colour of the specimen in spirit is dull white.

Specimen P : This is the most completely contracted specimen of a *Xenia* I have seen, and I refer it to this species with some hesitation. It has a capitulum 21 × 25 mm. on the end of a thick stalk 8 mm. in height springing from a wide membranous base, spreading over the surface of a branch of *Porites* to which the colony is attached.

The body-wall of the polyp is folded and contracted down to a height of not more than 1 mm. ; the tentacles are 1·25 mm. in length ; the pinnules are very short and blunt.

The spicules have an orange-brown colour like those of specimen O.

The colour of the colony in spirit is pale blue.

Notwithstanding the very striking differences between this specimen and others, I am inclined to the view that its peculiarities are all due to contraction. It has, like the others, three rows of pinnules on each side of the tentacles, and there are from 15–18 in each longitudinal row. There is nothing in the shape, size or distribution of the spicules to distinguish this specimen from the others.

Specimen Q has been described above. It was found in the same mangrove swamp as Specimen P.

Specimen R (Plate II, fig. 4) : This specimen, found in close proximity to specimen O, closely resembles it in every respect, except that it seems to be rather more contracted. In my original notes, made without reference to other specimens, I put down the statement that "the pinnules are low warts." On comparing it again with specimen O I find no reason to alter this statement, as I can find no polyps with pinnules as long or as pointed as they are in some of those in specimen O.

If we were to adopt the key plan of Kükenthal (1902) and other authors these two specimens would be placed in widely separated species.

Specimens: In this specimen there are four main stalks springing from an irregular base of attachment about 14 mm. in diameter. The highest stalk is 10 mm. in height, but seems to break up into a few secondary branches. The combined heads of these branches form a capitulum about 35 × 20 mm. in extent.

This specimen differs from the others not only in the more profuse branching of the stalk, but in characters which may be due to a different effect of contraction. The body-wall of the polyps is very short, the longest being 2–3 mm. and in many of them only 1 mm. The tentacles are also very short, none of them exceeding 2 mm. in length, but the pinnules seem to be all fully expanded, being the longest I have observed in the group, and in some cases 0·6 mm. in length and sharply pointed at the extremity.

The Genus CESPITULARIA, *Milne-Edwards.*

This genus was revised by Kükenthal (1902, p. 657). The principal characters are that the colony is dendritically branched and that the margin of the capitulum is not sharply defined, the polyps (*i. e.* the anthocodiae) arising not only from the summit of the branches, but in gradually diminishing numbers down their sides (see Plate I, fig. 2; Plate II, fig. 6).

Five species have hitherto been described:

Cespitularia mollis described by Brundin (1896, p. 4) from 120 metres of water in the Korea Straits; *C. multipinnata** and *C. subviridis** by Quoy and Gaimard from the Pacific Ocean, and *C. taeniata* and *C. coerulea* by May from Mozambique and Zanzibar respectively.

Three specimens of *C. coerulea* were also described by Thomson and Henderson (1906, p. 415) from Zanzibar. To these species it is now proposed to add two new ones, *C. wisharti* and *C. mantoni*, from the Great Barrier Reef.

C. mollis must be regarded as a distinct species not only on account of its exceptional geographical and bathymetrical position, but on account of the presence of spicules which are twins, quadruplets and hour-glass shaped (up to 0·05 mm. in size), sparsely distributed in the coenenchym and other characters.

All the other species are found in shallow tropical waters, and none of them have spicules with the same characters as those of *C. mollis*.

Spicules have not hitherto been described in any other species, but in the case of *C. multipinnata* and *C. subviridis* some very unsatisfactory figures of spicules are shown in the plate illustrating the type-specimens. It seems probable, therefore, that the type of *C. multipinnata* had spicules, although very improbable that they were spindle-shaped, as shown in the drawing. The type of *C. subviridis* was probably a *Xenia* (see p. 163).

C. mantoni is a new species distinguished by its very large spicules (Text-fig. 5, p. 168).

C. wisharti is a new species which resembles *C. multipinnata* in having numerous wart-like pinnules between the lateral rows, but has no spicules.

The Zanzibar species (*C. coerulea*) and the Mozambique species (*C. taeniata*) have no spicules, and there are no pinnules on the tentacles between the lateral rows. They differ from one another in minor characters, but may prove to be identical.

* These two species were described under the generic name *Cornularia.*

The species described and figured by Quoy and Gaimard as *Cornularia subviridis*, and subsequently referred to the genus *Cespitularia* by May, is not in my opinion a member of this genus at all. Neither the description nor the figures (Plate XXII, figs. 1–4) of the type suggest that it is branched or dendritic in form, and as it was said to be a foot in expanse it was certainly not a juvenile stage of a branched adult.

It has the appearance of an ordinary *Xenia*—probably *X. umbellata*—and the only point in which it has a remote resemblance to a *Cespitularia* is that one or two polyps are shown a little below the margin of the capitulum, but even in this respect it is unlike a typical *Cespitularia*, because in this genus the polyps below the summit of the branches are more numerous, extend further down the branch, and are smaller in size than those above them.

A specimen supposed to be a variety of *C. subviridis* described and figured by Quoy and Gaimard may be dimorphic and a *Heteroxenia*. It is certainly not a *Cespitularia*.

Notes on the Genus Cespitularia.—The generic name *Cespitularia* was founded by Valenciennes (in MS.) for the type-specimen of *Cornularia multipinnata* Q. & G. This specimen has never been satisfactorily described, but the generic name was accepted by May (1900, p. 89), and two new species supposed to belong to the same genus were added.

Kükenthal's definition of the genus given above is satisfactory for *C. mollis*, *C. taeniata* and *C. coerulea*, but is very unsatisfactory as a description of the type of *C. multipinnata* as it is figured by Quoy and Gaimard.

I have accepted the generic name with some hesitation on that account, but only on the assumption that some errors have crept into the description of the type species.

The species of the genus I have examined are distinguished from *Xenia* by the character that the polyps are more contractile, and that very often they are so far retracted as to be indicated only by low verrucae. From the descriptions of the other species this may be an additional diagnostic character.

None of the species are dimorphic, and in all the specimens examined the ventral and lateral mesenteric filaments are absent.

Cespitularia multipinnata, Q. & G.

Some confusion has arisen on account of the transposition of the description of the figures of *Cornularia multipinnata* and *C. subviridis* by Quoy and Gaimard. At the end of vol. iii there is a list of errata stating that the figures on pl. xxii, figs. 1–4, illustrate *Cornularia subviridis*, and on pl. xxii, figs. 5–7, illustrate *C. multipinnata*, and not as printed in the description of the plate.

The species has not been obtained since the voyage of the "Astrolabe," but has been referred to the genus *Cespitularia* by May (1900) and by Kükenthal (1902, p. 659) on the strength of the original description and figures by Quoy and Gaimard. If it is correct to refer the specimens obtained by the Barrier Expedition to this species, it must be assumed that the figures of the type are not quite accurate in several respects.

In the first place the spicules are drawn in the form of spiny spindles about 3 mm. in length. No statement is made as to the enlargement of any of the figures, so that we are left in the dark as to the actual size of these spicules, but neither the Barrier Reef specimens of this species nor any other known species of the family Xeniidae have

spindle-shaped spicules. All that it seems safe to assume is that the type had small spicules.

Kükenthal (1902, p. 660) says that there are "zahlreiche Pinnulae in 3–4 unregelmässigen Reihen auf der Innenseite der cylindrischen Tentakel."

In the original figures there are only a few scattered pinnules on the inner side of the tentacles between the two outer rows. There is no indication of rows of pinnules, regular or irregular, between the two lateral rows. I have not seen anything in any Xeniid corresponding with the original figure of the tentacle of the type.

The two specimens which I have referred to this species were collected on Three Isles about 75 miles north of Low Isle. They were labelled "Xeniid-like forms" ω and ω^2 respectively.

The character of the branching of both these colonies is better expressed by the term shrubby than dendritic (baumförmig), but in both of them the ramification is much more profuse than in any specimen of a true *Xenia* that I have seen.

Moreover the branches are not terminated by a capitulum with a well-defined margin, but the polyps (*i. e.* anthocodiae) are scattered irregularly and of various sizes over the upper part of the stalk in the longer branches or the whole of the stalk in the shorter branches (Plate II, fig. 6). There is so much variety in the size of the polyps that it is difficult to give measurements that have any exact meaning. If one of the largest polyps on one of the branches be taken, the body-wall is 2 or 3 mm. in height and 1·5 mm. in diameter, but other polyps on the same branch and of the same diameter have a height of less than 0·5 mm. On every branch there are smaller polyps with small but fully developed tentacles with no appreciable body-wall at all, the crown of tentacles being flush with the surface of the branch.

The largest tentacles are about 4 mm. in length, but the tentacles show many degrees of contraction. In a tentacle which seems to be fully expanded there is on each side an outer row of about 15 pointed pinnules, reaching a maximum size of 0·5 mm. On the oral surface of the tentacle there are numerous pinnules varying in shape from short pointed pinnules to low warts. These pinnules do not usually seem to have an orderly arrangement, but in some places there is roughly a series of four in an oblique row on each side. There may be also at the base a short space between the rows free from pinnules.

In most of the tentacles the pinnules are low warts scattered quite irregularly over the oral surface of the tentacle.

In both specimens there are numerous spicules in the body-wall and tentacles and in the stalk. They are mostly oval in shape and have a length of 0·03 mm. and a breadth of 0·025 mm. They are a trifle larger than the spicules in most of the species of *Xenia*. No mention is made in the literature of the presence of spicules in this species, but small spiny spindle-shaped spicules are figured by Quoy and Gaimard in the plate illustrating the type-specimen.

The two specimens are very much alike in general appearance, but in specimen ω the polyps are rather more contracted than in specimen ω^2.

In ω there is a very irregular base from which rises a very short stalk, breaking up almost immediately into numerous branches which again branch irregularly. The height of the colony is about 50 mm.

A careful examination of the polyps, the tentacles, the pinnules and the spicules does not show any material difference from the characters of these structures in specimen ω^2.

Cespitularia multipinnata ? juv.

A small specimen was found by Dr. Manton on Escape Reef in July, 1929, which may be a young stage of *C. multipinnata*. Escape Reef is on the outermost margin of the reef platform.

The specimen has a base of attachment 20 by 10 mm., and its greatest height is about 15 mm. It has a very short stalk, which divides into a number of short, lobate branches. As in other specimens of *Cespitularia* there is no clearly-defined margin to the capitula, small scattered polyps arising right down to the base. The polyps are very much smaller than they are in the specimens described above, and many of them are very slightly contracted. In the most fully expanded polyps the body-length is 1·25 mm. and the diameter 0·75 mm. The tentacles are 0·75 mm. in length.

There is a single row of 9 pinnules on each side of the tentacles and of these 4 are short and wart-like, and the distal 5 are long and digitiform with a maximum length of 0·2 mm.

There are numerous disc-shaped spicules in the polyps and in the stalk with a diameter of 0·025–0·03 mm.

The colour of this specimen, when alive, was blue. No gonads were observed.

The difference in the character of the tentacles of this specimen and of the type might appear to justify the proposal of a new species. It is not strictly speaking multipinnate. The general resemblances in other respects suggest that the median wart-like pinnules of the type may not appear until a later stage in growth. A point of some interest in this connection is that the spicules are all disc-shaped, and just that little bit larger than the spicules of most of the species of *Xenia*, which was noted in the larger specimens from Three Isles.

Cespitularia wisharti, n. sp. (Plate I, fig. 3.)

Two specimens belonging to this genus were found on Wishart's Reef in Low Isle (23.v.29). In general form and mode of growth they are similar to the specimens of *C. multipinnata* described above, but differ from them in several characters.

The colour in spirit is pale yellow, in striking contrast to the greenish-grey colour of the other species. The polyps are decidedly more fully expanded but smaller. The substance of the colony is soft and flabby, and there are no spicules either in the polyps or in the stalk.

The absence of spicules in the Xeniidae has usually been regarded as a negligible character in the determination of species, as it may be due to prolonged immersion in a preservative which is acid in reaction.

When I found that the spirit in which these specimens were preserved gave a slightly acid reaction, whereas the spirit in which the specimens of *C. multipinnata* were preserved was neutral, it seemed possible that this accounted for the absence of spicules in *C. wisharti*. It did not seem probable, however, that this slight acidity could account for the total absence of the spicules throughout the colonies.

To test the matter further some polyps and coenenchym of *C. multipinnata* were treated with weak HCl for some days and subsequently stained and mounted in balsam. These preparations were compared with preparations of *C. wisharti* similarly stained and mounted. The difference between them was striking. In the former spaces in the

epithelium were observed, which corresponded with the shape and size of dissolved spicules, and the epithelium was also ruptured in places where the gas had escaped. No such spaces were seen in the epithelium of the latter.

The conclusion therefore is that in this case at least, the absence of spicules is a good specific character.

The specimens are about 90 × 40 mm. and 80 × 20 mm. respectively in expanse and they are both about 40 mm. in height. Neither of them has a simple base of attachment. One of them has five quite distinct bases and the other two, all irregularly circular in shape, and from 10–15 mm. in diameter. The lower branches from these bases completely fuse, so that above the bases there is one indivisible colony. There seems to be no reason to suppose that this is due to the fusion of colonies which, in a younger stage, were distinct; but, as the supporting coral, or whatever it was, is missing, the manner in which the original colony spread cannot be determined.

The combined stalk from these bases gives rise to numerous columns dividing into lobate processes about 10 mm. in diameter and 40 mm. in height.

There are numerous polyps on the ends of these processes, fewer at the sides, and there are a few small stray polyps right to the base of the processes (Plate I, fig. 2).

The largest polyps are 1·5–2 mm. in height and about 0·6 mm. in diameter, and the tentacles are 1·6–2 mm. in length.

The difference in size, as expressed in figures, of these polyps and of those of *C. multipinnata* does not seem very considerable, but these specimens are clearly more fully expanded than the others, and probably the difference between them is still more pronounced in the living fully expanded condition.

On the oral side of the tentacles there are numerous pinnules, varying from long pointed forms 0·5 mm. in length to low warts. At the base of the tentacles the pinnules are sometimes arranged in two rows on each side with a space between them; in the middle there is no definite arrangement, but there are 4–5 pinnules across the width of the tentacle, and at the apex there are 4 or 5 pinnules in a single longitudinal row on each side with a broad space between them.

This seems to be the most usual arrangement of the pinnules, but there are some variations of it which may be due to contraction.

Cespitularia wisharti? (Plate II, fig. 7.)

A specimen from an unknown locality collected by the Expedition is marked "π ? ?," signifying, I suppose, that it might be the same species as the specimen of *C. wisharti* which was marked "π." It is adherent to a branch of dead coral, and consists of two parts connected together by a cylindrical band 5 mm. in diameter, only partially attached below to the coral, the whole being 45 mm. in length. The larger part is about 20 mm. wide by 15 mm. in height, and appears to be a typical *Cespitularia* colony with short lobes; the smaller part bears two short lobes about 8 mm. in height. Many of the polyps are greatly contracted, and some of them retracted into verrucae. The largest polyps, which are undoubtedly considerably contracted, have a body-length of 1 mm. and tentacles 0·5 mm. The tentacles are so much contracted that it is difficult to determine the exact arrangement of the pinnules. They are, however, certainly multipinnate, and in one polyp that was exceptionally well expanded the arrangement was as follows: at the apex of

the tentacle there were three pinnules in a single longitudinal row, with a space between them; in the middle of the tentacle there were in addition to the lateral pinnules a few low mound-like pinnules scattered about between them; at the base the median scattered pinnules were absent. The longest pinnules measured were only 0·07 mm. in length. There were no spicules in any part of the colony.

Another small specimen marked "π ?" and with a label marked "A 14 ? 11.iv.29" may provisionally be referred to this species. If the reference, A 14 = A 5 of the map, is correct, the specimen was found in the neighbourhood of the anchorage on Low Isle, and therefore not far from Wishart's Rock.

The specimen is remarkable in having the polyps more fully expanded than they are in any specimen of the genus I have seen.

It is 30 mm. in length, and divided by a short band into two parts as in the specimen described above. The larger end is 12 mm. wide and has four short lobes with the characteristic features.

The largest polyps have a body-length of 1 mm. but the slender tentacles are 2 mm. in length, and many of the delicate filamentous pinnules reach the extraordinary length of 0·6 mm.

The contrast between the tentacles of this specimen and of the other small specimen mentioned above is very striking. With a body-length of the polyp of approximately the same size, the tentacles of the former are 0·5 mm., of the latter 2 mm. in length, and the pinnules of the former 0·07 mm., and of the latter 0·6 in length.

There can be no doubt that the two specimens belong to the same species, and that this difference is only an instructive example of the contractility of the tentacles.

Cespitularia mantoni, n. sp. (Plate I, fig. 3.)

The single specimen for which I propose a new specific name was found by Dr. Manton in July, 1929, on Ruby Reef, a reef situated on the outermost margin of the Barrier platform.

It has a general resemblance, in spirit, to the small specimen of *C. multipinnata* found on the neighbouring Escape Reef, and like that specimen it was blue in colour when alive.

Miss Manton's note, however, " not the same species as that on Escape Reef," called for a detailed examination of the two specimens, and this led to the discovery of the very large spicules of this species and a confirmation of Miss Manton's field observation.

The specimen has an oval base of attachment 30 × 20 mm. There is a well-marked stalk about 10 mm. in height giving rise to about eighteen lobes of a typical *Cespitularia* character. They are about 10 mm. high by 8 mm. in diameter, irregular and discrete, and form a capitulum about 40 mm. in diameter. Many of the polyps are considerably contracted. The largest have a body-length 1·75 mm., and the most fully extended tentacles are less than one 1 mm. in length.

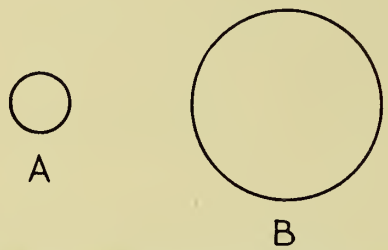
These small tentacles have a row of 4 or 5 pinnules on each side, with a broad space between them on which I can see no evidence of wart-like pinnules.

The most remarkable feature of the species is the enormous size of the spicules. Whereas in most species of the Xeniidae which have spicules the maximum size is 0·02–0·025 mm., in this species they are 0·1–0·12 mm. in diameter. They are therefore

four to five times greater in diameter than the spicules of any other species, and are quite visible to the naked eye in a section of the coenenchym (Text-fig. 5).

They are not very numerous nor of the maximum size in the tentacles and body-wall of the polyps, but in the coenenchym rows of these large brown spicules can be seen running parallel with the coelentera of the polyps. They are dark brown in colour and when isolated seem to be always round in outline, but, in some places, the round discs are fused together into irregular lumps.

The specimen was male with gonads 0·15 mm. in diameter.



Text-fig. 5.—These circles are drawn to scale to show the relative sizes of the spicules of A, *Cespitularia multipinnata* from Escape Reef, and of B, *Cespitularia mantoni* from Ruby Reef. Both these reefs are on the Outer Barrier.

The Genus HETEROXENIA, *Kölliker.*

The only definition of this genus that is necessary at present is: Xeniidae with dimorphic polyps. Possibly at some future time the S. African species may find a place under a new generic name; but it seems a better plan to keep them all together until our knowledge is extended.

The type of this genus is *Heteroxenia elisabethae*, Kölliker (1875), which was found at Port Denison, Queensland; other specimens attributed to the same species were obtained by Haddon from Torres Straits and by the Great Barrier Expedition from the Low Isles.

Ashworth (1899), Bourne (1895) and Thomson and Henderson (1906) have given the same name to specimens from Zanzibar, and Light (1915) records the species from the Philippine Islands.

Kükenthal (1902, p. 653) considered that the specimens described by Ashworth and by Bourne were distinct from Kölliker's type-species, and referred them to a new species, *X. ashworthi*, on the character of 3 pinnules in a row on the tentacles, instead of 4, as in the type. Thomson and Henderson in their description of specimens from Zanzibar state that the number of pinnules in a row is 4, but occasionally there are 5. Ashworth also distinctly states that although 3 pinnules in a row is the usual number, there may be 4 in a row at the base of the tentacles. May (1900, p. 85), who examined specimens from Zanzibar collected by Sander and Stuhlmann, said there are four rows of pinnules. If it could be shown that the specimens of this genus from the Red Sea and Zanzibar had invariably 3 pinnules in a row, and those from the Australian waters invariably 4, there would be some reason for considering the former to be specifically distinct from the latter, but as specimens from both localities have been described with three and four rows, this specific distinction cannot be maintained, and *Xenia* vel *Heteroxenia ashworthi* must lapse.

Kükenthal considered Kölliker's *Heteroxenia elisabethae* to be synonymous with Ehrenberg's *Xenia fuscescens*—a conclusion with which I cannot agree (see p. 173).

Other species which must be referred to the genus *Heteroxenia* are *H. capensis*, Hickson, from the Cape of Good Hope, *H. rigida*, May, from Mozambique, and *H. uniserta*, Kükenthal, from Simon's Bay.

Heteroxenia elisabethae differs from the other dimorphic species by the very obvious character that the siphonozooids in preserved specimens project 2–9 mm. from the surface of the stalk. The autozooids also appear to be less contractile than they are in the other species.

As *H. capensis* and the other two species, if they are distinct, exhibit a dimorphism similar in general characters to that of other dimorphic Alcyonaria, the whole controversy on the value of dimorphism as a character for generic importance depends upon the facts and interpretation of the characters of *H. elisabethae*. I have therefore made a careful study of the structure of the well-preserved specimen of this species collected by the Expedition, and compared it with that of all the other specimens I have been able to obtain.

In the collection made by the Barrier Reef Expedition there is one specimen of *Heteroxenia elisabethae* which I have described in detail on p. 173.

I have also examined three specimens of the same species collected by Prof. Haddon in Torres Straits, and six specimens collected by Dr. Crossland off Zanzibar.

The smallest specimen (from Zanzibar) is only 15 mm. in height, and the spread of the capitulum is only 12 mm., but the dimorphism of the polyps is as clearly seen as in the larger specimens.

With these specimens I have compared the descriptions and measurements of specimens described by Kölliker (1874), Ashworth (1899), May (1900), Kükenthal (1904), Thomson and Henderson (1906), and Cylkowski (1911), and I have constructed a table of the characters usually employed in the determination of the species of Xeniidae from the results thus obtained. My first object was to determine whether the Xeniids which have been described under this name represent only one species, two species or more than two species.

If there is only one species its geographical distribution is remarkable. It occurs in the Red Sea and off Zanzibar, but has not been found hitherto off Ceylon or in the archipelagos of the central part of the Indian Ocean.

It is found in the Philippine Archipelago (*fide* Light, 1915), and on the reefs of the East coast of Australia and Torres Straits. It may occur in the Malay Archipelago,* but no specimens have yet been recorded from that region, nor from Singapore. It does not occur so far as we know in any of the archipelagos of the Pacific Ocean.

If there is, as the evidence seems to prove, a very wide sea area between the localities in the east and in the west where it does not occur, it might be expected that some specific distinction between the specimens of the two regions would be found. All that can be said is that, at present, no such specific distinction has been found, and the species *Heteroxenia elisabethae* should be considered to be indivisible.

This statement is based on the consideration of the characters in my table referred to above and the following may be regarded as a summary of this table.

Size.—The largest specimen from the Australian region that has been described is the

* See Appendix, p. 177.

type from Port Denison. According to Kölliker's figure it was about 180 mm. in diameter across the capitulum and the stalk was 80 mm. in height. The smallest specimen from this region in my collection is only 15 mm. across the capitulum, and has a stalk 8 mm. in height.

There are not many data as to the actual size of the larger specimens from the Red Sea and Zanzibar areas. One specimen measured by Thomson and Henderson (1906, p. 413) had a capitulum with a diameter of 35 mm. and a stalk 25 mm. in height. There are reasons for believing that some of the specimens from the Red Sea were much larger than this one. The smallest specimen in the Crossland Collection has a capitulum 15 mm. in diameter and a stalk 10 mm. in height. There is no doubt that Kölliker's specimen from Port Denison is the largest that has been described. Apart from this there does not seem any reason to suppose that the specimens from the Australian region are larger on an average than those from the Red Sea region.

Size of the autozooids.—There is also a wide range of variation as regards the size of the autozooids. From the Australian region the autozooids of Kölliker's specimen were 20–40 mm. in height, of the specimen described in this paper 10 to 15 mm., and of some specimens in Haddon's collection only 5–7 mm.

From the Red Sea and Zanzibar region the autozooids of Ashworth's specimen were 10–25 mm. in height, of Thomson and Henderson's 15–22 mm., of Kükenthal's 20–40 mm., of Cylkowski's 3–50 mm.

There is clearly some correlation between the size of colony and the size of the autozooids: the larger the colony, the larger the autozooids.

If we take the expanse of the capitulum as the standard of the size of the colony and compare it with the size of the body of the largest autozooids, we get the following results:

	Diameter of capitulum.	Length of largest autozooids.
Kölliker's specimen	130	40
G.B.R.E. ,,	55	15
Haddon's ,,	25	5
Ashworth's ,,	about 30	25
Th. and H.'s ,,	35	22
Crossland's ,,	15	2

The figures given in these columns represent only the measurements of preserved specimens; no account is taken of the degree of contraction of autozooids, which, in some cases, is considerable. The autozooids of Haddon's specimens were obviously much more contracted than any of the others. If the measurements had been taken of the specimens alive in their natural position on the reef the figures would have been different, but I think there can be no doubt that a similar correlation between size of colony and size of autozooid would have been found.

The pinnules.—The tentacles of the autozooids in all the specimens of the species have numerous pinnules on both sides of the rachis. They are arranged roughly in oblique rows of three or four, and in longitudinal rows of 16–25 or more. In some cases the oblique rows are quite clear, but in others, particularly in those that are slightly contracted, the pinnules seem to be more unevenly distributed and the arrangement in rows is indistinct. It is always very difficult to determine with accuracy the exact number of pinnules in

every oblique row of a single tentacle, and still more difficult and time-absorbing to determine whether there are any variations in the number of pinnules in the oblique rows in the autozooids of a single colony.

Some authors in their descriptions of the species of the Xeniidae give a simple statement that the number of pinnules is 3 or 4 as the case may be.

Ashworth (1899), however, in his description of *H. elisabethae* from Zanzibar, says that the usual number of pinnules in a row is 3, but there may be 4 at the base of the tentacles. Thomson and Henderson (1906) in a description of specimens from the same locality say there are 4, but there may be 5. Cylkowski (1911) says there are 4, seldom 5 or 3 in specimens from Jidda.

When I first examined the specimen collected by the Great Barrier Reef Expedition I put down in my notes that there are 3 pinnules in an oblique row, but the number given by Kölliker for the type is 4. I endeavoured to find out some facts as to the variation in the number of pinnules by a careful examination of several tentacles. I took three autozooids from the middle of the capitulum and three from the periphery, dissected off the tentacles, and examined all of them by reflected and by transmitted light. The notes I made are as follows :

Median autozooids.—1. At the base and at the extremity of the tentacles there are 2 in a row, in the middle there are 3.

2. All the tentacles have 4 pinnules in a row except at the base, where there are 3.

3. All the tentacles have 4 in a row in the middle, 3 at the base.

Peripheral autozooids.—1. Distinctly 4 in a row in the middle.

2. At the base 3 or 4, in the middle 4, but in one tentacle there were not more than 3.

3. Some tentacles with 4 in a row, some with only 3.

From this evidence it is clear that the variation in the number of pinnules in a row is such that the separation of *H. ashworthi* from *H. elisabethae* proposed by Kükenthal is unsound.

Spicules.—According to Kölliker there were numerous spicules, 0·019–0·024 mm. × 0·01–0·015 mm. in size in the type-specimen. May, however, says that he could find spicules in only one of the specimens he examined. In the Great Barrier Reef Expedition specimen and in all the specimens in the Haddon collection I have examined there are numerous spicules approximately 0·025 × 0·02 mm. in size.

Bourne gives the size of the spicules of the specimen from Zanzibar as 0·02 × 0·01 mm. Thomson and Henderson say that in their specimens, also from Zanzibar, there are numerous spicules 0·001 mm. in diameter. (I think there must be a mistake or a misprint in this figure, as in the specimens of this collection which I have examined the spicules are at least 0·02 mm. in diameter.)

In the specimens called *X. fuscescens* by Kükenthal (1902, p. 654) the spicules are said to be present or absent, and in the specimens from Jidda, Cylkowski (1911, p. 4) says the spicules are absent.

Klunzinger (1877, p. 41) says the spicules of *X. fuscescens* are similar to those of *X. umbellata*, in which they are " 0·008 bis. 0·016–0·024 mm." in size.

According to my own observations the spicules of *H. elisabethae* are thin discs, oval or more irregular in shape with a maximum diameter of 0·025 mm.

The reported absence of spicules in some specimens is noteworthy. The spicules,

however, are often so thin and transparent that they may be easily overlooked, and if the preservative is acid in reaction they might be destroyed or rendered very inconspicuous. In any case the character of " absence of spicules " without confirmation cannot in this case be accepted as a sole ground for specific distinction.

Heteroxenia elisabethae, Kölliker.

Measurements in Millimetres.

Locality of specimens and authority.	Height of autozooids.	Height of siphono-zooids.	Length of tentacles.	Greatest diameter of spicules.	Number of pinnules in an oblique row.	Number of pinnules in a long row.
Port Denison, Kölliker . .	20–40	7–8	15	0·019-0·024	4	..
Torres Straits, Hickson . .	5–7	2-2·5	4–7	0·02–0·025	1, 2 or 3	18–20
Low Isles, Hickson . . .	15	9	6	0·02–0·025	3 or 4	20
Zanzibar, Ashworth . .	10–25	2–5	4–5	0·02	3 or 4	16–24
,, Th. & H. . . .	15–22	4–5	5·5–6·5	0·001 (?)	4	?
Sinai, Kükenthal . . .	20–40	3–5	15	Present or absent	4	?
Jidda, Cylkowski . . .	3–50	?	3–12	Absent	Rarely 3 or 5	..

Summary.—There is not any sound specific distinction between the *Heteroxenia elisabethae* of the Australian Barrier Reef and the *H. elisabethae* of the Red Sea and Zanzibar.

Three other species of the Xeniidae are undoubtedly dimorphic, and it may be observed that they all came from off the coast of S. Africa, and agree with each other in having a single row of pinnules on each side of the tentacles. They are : *H. rigida* (May, 1900, p. 80), which bore a label " Mozambique," with no record of depth, *H. capensis* (Hickson, 1900, p. 70), from 20 fathoms of water in False Bay, and *H. uniserta* (Kükenthal, (1906, p. 22), from 70 metres in Simon's Bay. May's specimen was said to be well preserved, and seems to have been fully expanded. The other two were evidently somewhat contracted, and it is possible if they had all been fully expanded some of the recorded differences between them would not have been apparent.

May's specimen which he called *Xenia rigida* must not be confounded with Thomson and Henderson's (1906, p. 413) species of the same name from Zanzibar. It was rather smaller than my specimen, but judging from the figure (May's pl. i, fig. 5), it was clearly dimorphic, although the siphonozooids are called polypbuds (Polypenknospen).

The autozooids attain to a length of 10 mm. and the tentacles to a length of 3 mm. The club-shaped siphonozooids are 4 mm. in height and 0·85 mm. in diameter at the upper end. The spicules are elliptic yellowish-brown scales 0·02 mm. in length.

The original description of *H. capensis* was not very full, but as I have still in my possession, and in good condition, the three series of sections which I made thirty years ago, I can now add a few details which are of importance in view of the controversy which has since arisen. There can be no doubt as to the dimorphism of this series. The differences between the autozooids and siphonozooids are quite as pronounced as they are in *Sarcophytum* or any other dimorphic Alcyonarian. This is shown by a study of the stomodaea of the two kinds of zooids and by other characters. In my original description I said that the siphonozooids are contracted. In my sections I find that some of them

project slightly into shallow pits on the surface, and it is probable that when the colony is fully expanded they do project slightly from the general surface. The sections also give some evidence that there may be rudimentary tentacles on the siphonozooids. The autozooids are decidedly smaller (6 mm.) than in *X. rigida*, but the tentacles are longer (4–6 mm.). The spicules are scarce in the coenenchym, absent in the polyps, and rarely more than 0·01 mm. in diameter.

Xenia uniserta of Kükenthal is also undoubtedly dimorphic. The excellent figures and description of the siphonozooids that he gave in his Valdivia report show that there is a striking similarity in structure between them and the siphonozooids of such a genus as *Paragorgia* or of a Pennatulid.

The autozooids are not so retractile as in *H. capensis*, and have a height of 9 mm. The tentacles are 3·7 mm. long, and the siphonozooids do not project from the surface.

Spicules are present throughout the colony, and are much larger (0·057 mm. in length) than in the other species.

These three species form a group which differs from the *H. elisabethae* in having only one row of pinnules on each side of the tentacles. The characters by which they differ from each other are not of sufficient importance to make it certain that they are specifically distinct, and as they all come from the same region it is probable they are only local varieties of one species. At present, however, only four specimens altogether have been described, and the question can only be definitely settled when by the examination of a number of specimens from one locality some idea can be obtained of their variability.

Heteroxenia elisabethae, Kölliker. (Plate I, fig. 1.)

In Ehrenberg's description of his species *Xenia fuscescens* in 1834 (p. 278) no mention is made of the occurrence of dimorphism of the polyps. Klunzinger (1877) reproduced a series of drawings made by Ehrenberg himself which show quite clearly both autozooids and siphonozooids, and said (p. 41) that they were intended for drawings of *X. fuscescens*. These drawings, however, were labelled "fusco-caerulea," not *X. fuscescens*, and all the specimens in the Berlin Museum were labelled "*X. umbellata*"; not a single one was found which was named *X. fuscescens*.

There is really no historical evidence that the type of *X. fuscescens* was dimorphic. Klunzinger said that except in the character of dimorphism *X. fuscescens* agrees with *X. umbellata*, but Kükenthal (1902, p. 642) places *X. umbellata* in a group with long pinnules, 3 in an oblique row, and *X. fuscescens* in a group with 4 pinnules in an oblique row. For reasons given elsewhere, I am convinced that this distinction for species is not sound, and consequently I am of opinion that *X. fuscescens* is a monomorphic form identical with *X. umbellata*.

The Expedition obtained only one specimen of this interesting species. It was found on Wishart's rocks on 23rd May, 1929.

It has a very short thick stalk, which is 10 mm. in height on one side, dwindling to 2 mm. on the other. When the colony was bisected it was found that the stalk is dome-shaped, having a height of 25 mm. in the middle, a maximum diameter of 30 mm. and a diameter at the base of attachment, which appears to be very much contracted, of 20 mm. The spread of the capitulum, including the autozooids, is about 55 mm.

The autozooids show signs of being slightly contracted. The largest of them have a

body-length of 15 mm. and a diameter of 1·75 mm. The tentacles are 6 mm. in length, and there are 3 or 4 pinnules in the oblique rows in the middle of the tentacles (see p. 171). There are about 20 pinnules in each longitudinal row.

The pinnules show various degrees of contraction; the largest are pointed at the extremity and 0·6 mm. in length.

The siphonozooids are numerous throughout the capitulum, roughly speaking about five or six times as many as the autozooids. They vary considerably in size, the largest being 9 mm. in height and 1 mm. in diameter. Each siphonozooid has 8 small tentacles about 0·2 mm. in length. These tentacles are folded over the oral area and difficult to observe in whole mounts, but after careful examination and dissection I cannot find any evidence that they bear pinnules.

Spicules are numerous in the autozooids, siphonozooids and stalk. The majority are thin discs having a maximum diameter of 0·025 mm. There are some twins, having a shape like a "cottage" loaf, and some smaller rod-shaped spicules. There are very few that are oval in shape. It seems to be a character of the spicules of this specimen that the outline is more irregular and the shapes more varied than in most of the Xeniids.

Gonads.—The coelenteric cavities of the autozooids bear numerous female gonads of various sizes up to a maximum diameter of about 0·75 mm.

The Genus SYMPODIUM, *Ehrenberg.*

Ehrenberg (1834, p. 285) referred a number of species to this genus, and among them were *S. fuliginosum* and *S. caeruleum* from the Red Sea. Klunzinger (1877, pp. 42, 43) gave a further account of these species and refers to the blue colour of the former. He also described *Anthelia glauca* and *A. strumosa* with a blue-green colour. Kükenthal (1904, pp. 39, 43) described these species more fully, but referred *S. fuliginosum* to the genus *Anthelia* and included *A. glauca* and *A. strumosa* in the same species.

From the descriptions of these authors it seems certain that in all these species the polyps are not retractile, that there are more than the two longitudinal rows of pinnules on the tentacles, and that the spicules, when present, are minute rods or discs. In 1916 Kükenthal announced that in *Sympodium caeruleum* the dorsal mesenteric filaments alone persist and the genus was transferred to the family Xeniidae.

I have found in the Cambridge Museum a small specimen of uncertain locality, but probably from Zanzibar, which agrees very closely with the description given by Kükenthal of *Anthelia fuliginosa*. The polyps are of approximately the same size, and the spicules are of the same size and shape. In this specimen the dorsal mesenteric filaments alone are present. *Anthelia fuliginosa* is therefore undoubtedly a Xeniid, and I see no reason why it should not be referred back to the genus *Sympodium*. In Kükenthal's 'Handbuch der Zoologie' of 1925 *Anthelia* is placed in his family Cornulariidae, but the only difference of any great importance between *Sympodium* and *Anthelia* in his account of these genera in 1916 is that the polyps of the former are more contractile than those of the latter.

I have recently (1930, p. 238) given reasons for suggesting that the generic name "*Anthelia*" should be suppressed.

The genus *Sympodium*, as it now stands, is a Xeniid, and the only character in which it seems to differ from *Xenia* is that the polyps do not form a syndete, but stand apart on a membranous stolon.

In my description of *Xenia nana* (1931, p. 84) I have given reasons for believing that a sympodium-like stage may occur in the development of the Xenias, and that this stage may persist for some time in growth, if there is room on the support for lateral expansion. It is an open question, therefore, whether the species referred to the genus *Sympodium* are not young stages or growth varieties of species of *Xenia*. As this question can only be answered by a special study on the reefs, it may be convenient to retain the genus *Sympodium*.

If this course be adopted a number of species which have been referred to the genus *Clavularia* should be transferred to this genus.

They seem to agree with the Xeniids in having more than one row of pinnules on the tentacles, in having minute spicules or no spicules at all, and in the non-retractile polyps. It is not known, however, whether they have the full number of mesenteric filaments. If it can be proved that they possess the dorsal pair of filaments only, their position is undoubtedly in the family Xeniidae.

In the more typical forms of *Clavularia* there is only one row of pinnules on each side of the tentacles; the spicules, when present, are usually relatively large and often spindle-shaped, and there is a full complement of 8 mesenteric filaments.

Among the species that should now be transferred to the Xeniidae are the following:

Clavularia garciae (Hickson, 1894, p. 341) with rod-shaped spicules. The type-specimen of this species has unfortunately been lost. *C. flava* (May, 1900, p. 43) with oval spicules. *C. gracilis* (May, 1900, p. 41) with no spicules. *C. crosslandi* (Th. & H., 1906, p. 404) with oval spicules. *C. zanzibarensis* (Th. & H., 1906, p. 404) with no spicules. *C. pulchra* (Th. & H., 1906, p. 404) with rod-shaped spicules. *C. mollis* and *C. pregnans* (Th. & H., 1906, pp. 406 and 407) with no spicules. The *Anthelia strumosa* of Ehrenberg was transferred to *Clavularia* by subsequent authors, but according to the accounts of the species given by May and Thomson and Henderson this species must also be a Xeniid. May states that the spicules of his specimen were "Stumpfe Stäbschen," 0·032 mm. in length, but Thomson and Henderson described the spicules as oval or roundish discs, 0·02 × 0·016–0·018 mm.

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APPENDIX.

After this report was written, Sir Arthur Thomson very kindly let me see the proof of the Monograph he is publishing, with the co-operation of Miss I. Dean, on "Some of the Alcyonaria Collected by the 'Siboga' Expedition."

They record the occurrence of the following species of Xeniidae in the waters of the Malay Archipelago: *Xenia crassa*, *X. florida*, *X. fusca*, *X. garciae*, *X. membranacea*, *X. novae-britanniae*, *X. ternatana*, *X. umbellata*, *X. viridis*, and two species which, in my opinion, should be referred to the genus *Heteroxenia*, namely *H. ashworthi* and *H. capensis*. They also describe a new species of *Cespitularia*, as well as specimens of *C. coerulea* and *C. taeniata*. They record the occurrence of *Sympodium coeruleum* in this region, and the following species attributed to the genus *Anthelia*; *A. garciae*, *A. glauca*, *A. ternatana* and a new species.

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DESCRIPTION OF PLATE I.

All the photographs taken in spirit by Messrs. Hills & Saunders, Cambridge.

Fig. 1.—*Heteroxenia elisabethae*, Kölliker. View of a section through the whole colony showing the long autozooids with tentacles fully expanded and the shorter siphonozooids. The gonads are seen in the cavities of the autozooids.

Fig. 2.—*Cespitularia wisharti*, n. sp. A part of the colony of the type-specimen. This photograph shows polyps arising from the stalk as well as from the capitulum, the characteristic feature of the genus.

Fig. 3.—*Cespitularia mantoni*, n. sp. Seen from above, showing the lobate character of the branches and many of the polyps retracted.

FIG. 1.

FIG. 2.

FIG. 3.

[*Adlard & Son,*

DESCRIPTION OF PLATE II.

All the photographs taken in spirit by Messrs. Hills & Saunders, Cambridge.

Fig. 4.—*Xenia crassa*, Schenk. Specimen R described on p. 161. × 1½ diams.

Fig. 5.—*Xenia plicata*, Schenk. Specimen from Batt Reef described on p. 158. Nat. size. Note that the polyps and tentacles are longer than in *X. crassa*.

Fig. 6.—*Cespitularia multipinnata*, Quoy & Gaimard. A part of the colony of specimen ω from Three Isles.

Fig. 7.—*Cespitularia wisharti*, n. sp. The young specimen from an unknown locality described on p. 166.

FIG. 4.

FIG. 5.